Photovac Voyager Portable GC User's Guide

Warning: Limitation of Liability

The ultimate responsibility of the consequences of use of toxic compounds rests with the user. PerkinElmer Photovac's role is as a supplier of instrumentation to assist in the early detection of hazardous conditions involving such compounds.

Voyager represents a major advance in this field and, as with all complex instruments, it is vitally important to ensure that Voyager is maintained in accordance with PerkinElmer Photovac's instructions and that proper calibration is regularly performed.

As with any complex device, Voyager is subject to failure and, while PerkinElmer Photovac has taken, and continues to take, all possible precautions to (a) reduce the possibility of failure, and (b) warn the user in the event of failure, circumstances may occasionally occur in which there is a failure despite such precautions on PerkinElmer Photovac's part. PerkinElmer Photovac regrets that it cannot accept liability for damages of any kind caused as a result of either failure of the user to follow instructions or of Voyager to perform.

Release History

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Warnings and Safety Information 1

Standard Warnings

FCC Warning

This equipment has been tested and found to comply with the limits for a Class A Digital Device, pursuant to Subpart B, Class A of Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their own expense.

CE Directive

CE

CONFORMS TO
COUNCIL DIRECTIVE 89/336/EEC
COUNCIL DIRECTIVE 91/157/EEC

Council Directive 89/336/EEC - Electromagnetic Compatibility and the Applicable Standards. Voyager complies with EN50082-01 Generic Immunity Standard for Electromagnetic Compatibility Part 1: Light Industrial Environment. Voyager has been tested and conforms to the guidelines specified in EN50082-02 Generic Immunity Standard for Electromagnetic Compatibility Part 2: Industrial Environment

Council Directive 91/157/EEC - Recovery and Disposal of Spent Batteries. You must use the 220 V AC adapter (Part No. MX380330 or MX380331) in order to comply with the requirements of the applicable Council Directives.

Radio Frequency (RF) Generating Devices

The use of RF generating devices, such as radio transmitters, cellular phones, etc., within a 10 meter radius can cause momentary interference in the performance of Voyager, with respect to the signal levels being detected.

Internal Carrier Gas Cylinder

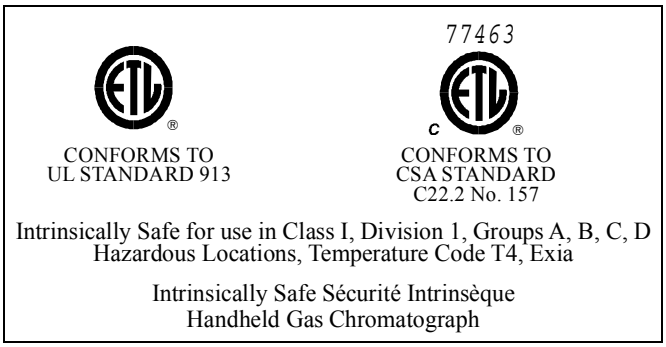
WARNING

This device contains a high pressure aluminum alloy cylinder maximum pressure - 1800 psi.

Improper use, filling, storage, or disposal of the cylinder contained within this device may result in death, personal injury and property damage.

- Do not alter this cylinder or the high pressure components of this device, in any way.
- Do not over pressurize this cylinder (device).
- Do not expose pressurized cylinder (device) to temperatures in excess of 54 °C (130 °F).
- Cylinders exposed to a fire or heated to temperatures in excess of 177 °C (350 °F) should be condemned or hydrostatically tested prior to filling.
- Do not remove the warning label.

I/S Notice


77463
CONFORMS TO
UL STANDARD 913
CONFORMS TO
CSA STANDARD
C22.2 No. 157
Intrinsically Safe for use in Class I, Division 1, Groups A, B, C, D
Hazardous Locations, Temperature Code T4, Exia
Intrinsically Safe Sécurité Intrinsèque
Handheld Gas Chromatograph

VOYAGER I/S IS CLASSIFIED FOR USE IN CLASS I, DIVISION 1, GROUPS A, B, C, D HAZARDOUS LOCATIONS. T4 (135 ºC) RATING.

It has been listed by ETL® to comply with Underwriters Laboratories® Inc. UL® 913 Standard for Intrinsically Safe Apparatus and Associated Apparatus for use in Class I, Division 1, Groups A, B, C, D Hazardous (Classified) Locations, Fourth Edition.

It has been listed by ETL to comply with CSA Standard 22.2 No. 157-92 Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations.

VOYAGER I/S IS NOT INTENDED TO DETECT COMBUSTIBLE LEVELS OF GASES. VOYAGER I/S IS CLASSIFIED FOR USE IN ATMOSPHERES CONTAINING COMBUSTIBLE LEVELS OF GASES.

These PerkinElmer Photovac optional accessories are for use with Voyager I/S in a hazardous location:

Part Number	Description
MX380305	Three Meter Sample Line
MX380310	Calibration Kit, Assay 1

Part Number	Description
MX380311	Telescoping Sample Probe
MX380312	Carrying Harness
MX380316	Carrying Case
MX380337	Calibration Kit, Assay 2-7
MX396001	Short Sample Probe

NOTE: *Do not use any other accessories with Voyager I/S in a hazardous location. Substitution of components may affect safety rating.*

WARNING

To reduce the risk of fire or injury to persons, read and follow these instructions:

- *All calibration, maintenance and servicing of this device, including battery charging, must be performed in a safe area away from hazardous locations.*
- *For replacement battery pack use only MX380314 or MX380315.*
- *Do not dispose of the battery pack in a fire. The cell may explode. The battery pack contains 20% cadmium (Cd) by weight. This battery pack must be disposed of properly. Check with local codes for special disposal instructions. Alternatively, you can return the battery pack to the nearest PerkinElmer Photovac facility for recycling.*
- *Do not open or mutilate the battery pack. It may be toxic if swallowed.*
- *Exercise care in handling battery packs in order not to short the terminals with conducting materials such as rings, bracelets and keys. The battery or conductor may overheat and cause burns.*
- *Do not defeat proper polarity orientation between the battery pack and battery charger.*
- *Charge the battery pack using the charger provided with or identified for use with this product only in accordance with the instructions and limitations specified in this manual. For battery charger use only Part No. MX380302 (110 Volts AC).*

Ex Notice

CONFORMS TO
EEx ib m IIC T4.
DEMKO NO. 97D. 121971

Handheld gas chromatograph classified by Demko as instrinsically safe for use in Zone 1 Locations.

VOYAGER EX IS CLASSIFIED FOR USE IN ZONE 1 HAZARDOUS LOCATIONS.

Voyager Ex complies with the harmonized European Standards EN50014 incl. amd. 1 - 5, EN50020 incl. amd. 1 - 2.

VOYAGER EX IS NOT INTENDED TO DETECT COMBUSTIBLE LEVELS OF GASES. VOYAGER EX IS CLASSIFIED FOR USE IN ATMOSPHERES CONTAINING COMBUSTIBLE LEVELS OF GASES.

These optional accessories may be used with Voyager Ex in a hazardous location:

Part Number	Description
MX380305	Three Meter Sample Line
MX380310	Calibration Kit, Assay 1
MX380311	Telescoping Sample Probe
MX380312	Carrying Harness
MX380316	Carrying Case
MX380337	Calibration Kit, Assay 2-7

Part Number	Description
MX396001	Short Sample Probe

NOTE: *Do not use any other accessories with Voyager Ex in a hazardous location. Substitution of components will invalidate the certificate.*

WARNING

To reduce the risk of fire or injury to persons, read and follow these instructions:

- *All calibration, maintenance and servicing of this device, including battery charging, must be performed in a safe area away from hazardous locations.*
- *For replacement battery pack use only Part Numbers MX380359 or MX380360.*
- *Do not dispose of the battery pack in a fire. The cell may explode. The battery pack contains 20% cadmium (Cd) by weight. This battery pack must be disposed of properly. Check with local codes for special disposal instructions. Alternatively, you can return the battery pack to the nearest PerkinElmer Photovac facility for recycling.*
- *Do not open or mutilate the battery pack.*
- *Exercise care in handling battery packs in order not to short the terminals with conducting materials such as rings, bracelets and keys. The battery or conductor may overheat and cause burns.*
- *Do not defeat proper polarity orientation between the battery pack and battery charger.*
- *Charge the battery pack provided with or identified for use with this product only in accordance with the instructions and limitations specified in this manual. For battery charger use only Part No. MX380330 (United Kingdom), MX380331 (Europe).*

Safe Working Practices

NOTE: *The following information is important, please read carefully before using Voyager.*

Compressed Gases

WARNING

Cylinders of compressed gas, such as the carrier gas and calibration gas, must be handled with care.

Please observe the following handling procedures:

- Ensure each tank is clearly labeled.
- Do not store cylinders in hazardous locations. Store cylinders in an upright position away from possible sources of heat or sparks.
- Do not heat the cylinders or expose them to direct sunlight. The cylinders may rupture at high temperatures.
- Do not mutilate cylinders.
- Do not drag or roll cylinders. Large cylinders should only be moved on carts designed for compressed gas cylinders. Do not move cylinders without the valve protection cap in place.
- Always secure cylinders before removing the cylinder valve protection cap. Always secure the calibration gas cylinder before connecting the regulator and adapter tubing.
- Use only the specified regulator for the carrier and calibration gas cylinders.
- Never transport Voyager while it is connected to a cylinder.

- Never plug, obstruct or tamper with safety relief devices.
- Wear safety glasses and ear protection when working with compressed gases.

Regulators for Compressed Gases

- Use only the specified regulator for carrier and calibration gas. Confirm regulator type and material with your specialty gas supplier.
- Use the carrier gas filling station only for refilling the internal carrier gas cylinder (MX380303 for nitrogen or MX380319 for air).
- Mark each regulator with its intended service and never use a regulator for more than one service. Do not change gas service, or adapt equipment without consulting your gas supplier.
- Ensure regulator construction materials are compatible with the gas, and that the cylinder pressure gauge will withstand the cylinder pressure. A stainless steel diaphragm is suggested as this will reduce the potential for the carrier gas to be contaminated by the regulator itself.
- Never use the regulator as a shut-off valve. Close the cylinder valve when it is not in use.
- Do not subject the regulator to an inlet pressure greater than recommended.
- Do not move or detach the regulator when it is pressurized or when it is in use.
- Before connection, ensure the cylinder valve and the regulator CGA connection are clean.
- When connecting a regulator to a large gas cylinder turn the valve on the cylinder clockwise to close the cylinder. Turn the regulator off. Open the cylinder valve slowly and check for leaks. Adjust the delivery pressure and then open the regulator outlet valve.

Battery Pack Care

The battery pack contains 20% cadmium (Cd) by weight. This battery pack must be disposed of properly. Check with local codes for special disposal instructions. Alternatively, you can return the battery pack to the nearest PerkinElmer Photovac facility for recycling.

Charge the battery pack using the AC adapter provided with, or identified for use with, this product only, in accordance with the instructions and limitations specified in this manual.

Excessive Heat and Cold

The normal operating temperature is 0 °C to 40 °C (32 °F to 105 °F) with 0 to 95% (non-condensing) relative humidity.

Do not expose the instrument to intense sunlight for prolonged periods. This may result in a rise in instrument temperature and loss of oven control. Exposure to excessive heat may also result in instrument contamination. Low temperatures will cause decreased battery life and may also result in loss of oven control. The plastics may become fragile and shatter at extreme low temperatures.

An insulated soft case (MX380317) is available as an option to protect Voyager in excessive hot or cold environments.

Adequate Ventilation

If compound threshold limit values (TLVs) are exceeded, you should use a gas bag and the gas bag adapter for sampling and provide adequate ventilation during calibration. When using the gas bag adapter tubing, do not kink or stress the tubing. The gas bag and gas bag adapter are available in both calibration kit, assay 1 and calibration kit, assay 2-7 (MX380310 and MX380337).

Optionally you can vent the detector out, pump and vent ports. Use flexible tubing fitted with luer adapters to vent these ports to a fume hood or outdoors. The detector out ports vent the effluent from the PID (port 1) and ECD (port 2). The pressure set by the method will determine the outlet flow rates at these ports. If the detector is not in use Voyager supplies a maintenance flow to ensure the detector is ready for operation.

Samples drawn by the pump to fill and flush the sampling system are vented through the pump out port. The flow though this port is approximately 250 ml/min when the pump is on. The two columns that are not in use are flushed constantly with approximately 1 mL/min. The two columns are both vented through the vent out port.

ECD Safety Practices

WARNING

To assure that removable radioactive contamination on the external parts of the ECD remains at a safe level, the United States Nuclear Regulatory Commission requires that the ECD be wipe tested at least once every six months. A record of the results must be maintained for NRC inspection for a period of three subsequent years.

In Canada, the ECD must be wipe tested at least once every twelve months and a record of the results must be maintained for Atomic Energy Control Board (AECB) inspection for a period of three years.

WARNING

Thermal Runaway Protection: *Voyager will cut power to the heating system if any heated zone exceeds 120 °C.*

Government Regulations for ECDs

NOTE: *Do not open the instrument or attempt to remove the ECD. If the ECD must be removed from the instrument, contact PerkinElmer Photovac.*

NOTE: *The electron capture detector contains 15 millicuries of nickel-63 (Ni^{63}), a radioactive material. We strongly recommended that you become familiar with the NRC regulations, as well as any other federal, state, or local regulations, covering the use of Ni^{63}.*

Your possession and use of this detector is governed, in the U.S., by 10 C.F.R. Section 31.5, as noted on page 462. Under the provisions of that regulation you are deemed a General Licensee.

If you hold a specific license, you may need to meet additional requirements and be governed by further regulations as outlined in your license.

Your possession and use of the ECD may also be regulated by the state where you are located. The requirements of state regulatory agencies are similar to those contained in NRC regulation 10 C.F.R. Section 31.5, but they may differ in some respects. You must obtain a copy of the regulations from your particular state. See page 475 for a list of the Agreement States. Agreement States have been granted authority by the U.S. Nuclear Regulatory Commission to regulate the possession and use of radioactive material.

In Canada, use of the ECD is governed by Atomic Energy Control Regulations. Under these regulations, you must obtain a possession license before you can receive the ECD. Refer to Part II, Section 7, of the regulations for details of applying for a license, as noted on page 467.

You must be familiar with all the regulations governing your use of the ECD. A summary of the requirements of 10 C.F.R. Section 31.5 is listed below. The requirements of the Atomic Energy Control Regulations are similar to those of 10 C.F.R. Section 31.5.

Labels

Do not remove any of the labels attached to the ECD cell or any of the labels attached to your gas chromatograph that refer to the ECD cell. Follow all instructions and abide by all precautions provided by the labels and in user instruction manuals referred to by the labels.

Leak Testing

You are obligated under federal and state regulations to make certain that the ECD cell is wipe tested for leakage of radioactive materials at intervals of no longer than 6 months, and that the analysis of these wipe tests is conducted by a person specifically licensed to do so, either by the U.S. Nuclear Regulatory Commission or by an Agreement State. The analyses can be performed by the organizations listed under *Wipe Test Agencies* starting on page 480.

In Canada, the ECD must be wipe tested at least once every twelve months and a record of the results must be maintained for AECB inspection for a period of three years. See *Obtaining an ECD Wipe Test Sample* on page 268for detailed procedure.

Cell Failure or Damage

If a leak test detects more than 0.005 microcuries of removable Ni^{63} on the surface of the ECD cell, or if the cell itself is damaged in such a way as to indicate that it may no longer adequately shield the radioactive material inside, you must immediately suspend operation of your gas chromatograph until the cell has been repaired or disposed of by a person specifically licensed to do so.

You must report any such incident, to the Regional Office, Inspection and Enforcement, U.S. Nuclear Regulatory Commission. You must also report the incident to the regulatory authority of your Agreement State.

In Canada, you must report the incident to the AECB, see page 479.

Reporting Radiation Incidents, Theft or Loss

Please read NRC Regulation 10 C.F.R. Section 20.2201 and 20.2202, as reproduced starting on page 454.

In Canada, read Atomic Energy Control Regulations, Part VI, Section 20, as reproduced starting on page 471.

These regulations describe your duties should Voyager, equipped with an ECD, be lost, stolen, or released, or should any person be exposed to radiation.

Other Requirements

Regulation 10 C.F.R. Section 31.5 does not permit you to abandon Voyager, equipped with an ECD, or export it. It may not be transferred except to a person specifically licensed to receive it. Within thirty days of such a transfer, you must report to the Director of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, the name and address of the transferee.

A report is not required, by the NRC, to transfer a used or defective Voyager, equipped with an ECD, to PerkinElmer Photovac in order to obtain a replacement. You may transfer Voyager, equipped with an ECD, to another general licensee, like yourself, only when it remains at the same location to which it was shipped by PerkinElmer Photovac. Give the transferee a copy of these instructions and the regulations and report to the NRC as required in Regulation 10 C.F.R. Section 31.5.

WARNING

Do not open or disassemble Voyager.

Introduction 2

About this User's Guide

This manual provides detailed instructions for setup, operation and maintenance of the PerkinElmer Photovac Voyager Portable Gas Chromatograph.

Conventions used in this manual

- Normal text is used to provide information and instructions.
- **Standard Bold** text refers to Fixed keys on the instrument.
- UPPERCASE text refers to Soft keys on the screen of the instrument.
- ***Bold Italic*** text refers to keys on the PC keyboard.
- **Non-serif Bold** text refers to text that is displayed on the PC screen.
- All eight digit numbers are PerkinElmer Photovac part numbers unless stated otherwise.
- To provide keyboard information, the following shortcut key sequences are used:

Shift + ***Tab***	Hold down the ***Shift*** key while pressing the ***Tab*** key.
F, ***A***	Press and release each of these keys in order: First F, and then A.
Arrow Keys	This is the collective name for the UP ARROW, DOWN ARROW, LEFT ARROW and RIGHT ARROW keys.

- Three mouse actions are used in most procedures:

Point	Moving the mouse to place the pointer over an item is called pointing.
Click	Pointing to an item on your screen and then quickly pressing and releasing the left mouse button is called clicking.
Drag	Holding down the left mouse button as you move the pointer is called dragging.

Notes, cautions and warnings

Three terms, in the following standard formats, are also used to highlight special circumstances and warnings.

NOTE: *A note indicates additional, significant information that is provided with some procedures.*

CAUTION	*We use the term CAUTION to inform you about situations that could result in **serious damage to the instrument** or other equipment. Details about these circumstances are in a box like this one.*
D	***Caution (Achtung)*** *Bedeutet, daß die genannte Anleitung genau befolgt werden muß, um einen **Geräteschaden** zu vermeiden.*
DK	***Caution (Bemærk)*** *Dette betyder, at den nævnte vejledning skal overholdes nøje for at undgå en **beskadigelse af apparatet**.*
E	***Caution (Advertencia)*** *Utilizamos el término **CAUTION** (ADVERTENCIA) para advertir sobre situaciones que pueden provocar **averías graves en este equipo** o en otros. En recuadros éste se proporciona información sobre este tipo de circunstancias.*
F	***Caution (Attention)*** *Nous utilisons le terme **CAUTION** (ATTENTION) pour signaler les situations susceptibles de provoquer de **graves détériorations de l'instrument** ou d'autre matériel. Les détails sur ces circonstances figurent dans un encadré semblable à celui-ci.*
I	***Caution (Attenzione)*** *Con il termine **CAUTION** (ATTENZIONE) vengono segnalate situazioni che potrebbero arrecare **gravi danni allo strumento** o ad altra apparecchiatura. Troverete informazioni su tali circostanze in un riquadro come questo.*
NL	***Caution (Opgelet)*** *Betekent dat de genoemde handleiding nauwkeurig moet worden opgevolgd, om **beschadiging van het instrument** te voorkomen.*
P	***Caution (Atenção)*** *Significa que a instrução referida tem de ser respeitada para evitar a **danificação do aparelho**.*

WARNING

*We use the term WARNING to inform you about situations that could result in **personal injury** to yourself or other persons. Details about these circumstances are in a box like this one.*

D

Warning (Warnung)
*Bedeutet, daß es bei Nichtbeachten der genannten Anweisung zu einer **Verletzung** des Benutzers kommen kann.*

DK

Warning (Advarsel)
*Betyder, at brugeren kan blive **kvæstet**, hvis anvisningen ikke overholdes.*

E

Warning (Peligro)
*Utilizamos el término **WARNING** (PELIGRO) para informarle sobre situaciones que pueden provocar **daños personales** a usted o a otras personas. En los recuadros como éste se proporciona información sobre este tipo de circunstancias.*

F

Warning (Danger)
*Nous utilisons la formule **WARNING** (DANGER) pour avertir des situations pouvant occasionner des **dommages corporels** à l'utilisateur ou à d'autres personnes. Les détails sur ces circonstances sont données dans un encadré semblable à celui-ci.*

I

Warning (Pericolo)
*Con il termine **WARNING** (PERICOLO) vengono segnalate situazioni che potrebbero provocare **incidenti alle persone**. Troverete informazioni su tali circostanze in un riquadro come questo.*

NL

Warning (Waarschuwing)
*Betekent dat, wanneer de genoemde aanwijzing niet in acht wordt genomen, dit kan leiden tot **verwondingen** van de gebruiker.*

P

Warning (Aviso)
*Significa que a não observância da instrução referida poderá causar um **ferimento** ao usuário.*

A Brief Overview

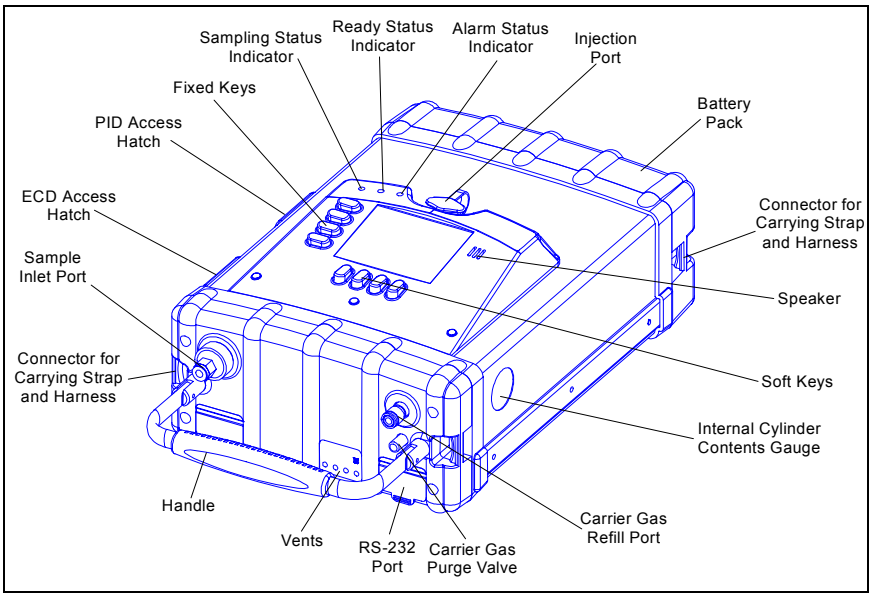


Figure 1 Voyager Layout

Voyager is a portable, automatic gas analyzer for identifying airborne chemicals and measuring their concentrations.

Voyager uses a gas chromatograph (GC) to analyze air samples, but you do not need to understand the principles of chromatography to operate Voyager. Voyager collects a sample of air and automatically introduces the sample into the GC. Voyager manages the gas flows and timing during the analysis, and compares the outcome of the analysis against the outcome of a previous analysis of a calibration standard of known composition. Voyager then reports the analysis results on its display, by compound name and concentration. Voyager alerts you with audible and visual alarms if any of the detected chemical compounds have exceeded your alarm concentration set points. Voyager stores the analysis results in its internal datalogger.

Voyager's GC uses the technique of precolumn backflushing to enable fast analysis times. In order to analyze a wide range of different compounds, Voyager is fitted with three separate analytical columns in its GC. It is not necessary for you to change GC columns; column selection is automatic in Voyager. The columns are operated at a controlled elevated temperature for precise identification of compounds.

Approved Models of Voyager

This manual provides operational instructions for all models of Voyager. Voyager I/S and Voyager Ex are intrinsically safe and approved for use in hazardous locations. Throughout the manual, notes are provided to inform you of the limitations of usage for the intrinsically safe models.

WARNING

If the Voyager model you are using is not specifically identified as intrinsically safe, do not use it in a location where flammable concentrations of gases and vapors may exist.

Unpacking and Checking Parts

WARNING

Before unpacking the instrument, please read the Warnings and Safety section of this User's Guide. This section describes possible hazards that might injure the user, damage the instrument, or compromise its operation. Some general safety information is also provided.

The first time you unpack the Voyager you should check that the following accessories are not missing or damaged, and if there is any problem, contact PerkinElmer Photovac immediately.

- Voyager User's Guide
- SiteChart Software
- User's Reference Card
- Communication Cable Kit
- Carrying Strap
- Tool Kit (pouch, multi-tool, and 2 hex keys)
- Battery Pack
- Carrier Gas Connection Kit
- AC Adapter
- Sample Inlet Filters (10 pieces)
- Septa (10 pieces)
- Factory Programmed Assay Diskette

Battery Pack

Voyager uses a rechargeable nickel cadmium battery, rated for 300 charge/discharge cycles, which is equivalent to a very heavy year of Voyager activity.

When the internal battery voltage is low, Voyager will display a low battery fault and then after approximately 5 minutes, will shut itself off. This is a battery protection measure, since deep discharging damages the battery. To resume operation, connect Voyager to an AC power supply using the AC adapter or replace the battery pack with a fully charged one.

When the instrument is plugged into the AC adapter, the adapter will charge the battery at a high rate. When the battery is fully charged the AC adapter will maintain the full charge.

A fully charged standard battery pack will power Voyager for approximately 4-6 hours. This will depend on the oven temperature, whether or not the backlighting is on or off and on the ambient conditions. An extended life battery pack will provide approximately 6-8 hours of operation.

Before beginning operation of Voyager, the battery pack must be charged. You can connect the battery charger to the battery pack while the battery pack is still attached to Voyager.

You can also remove the battery pack and replace it with a fully charged, spare pack (MX380314 or MX380315) and charge the battery pack independently of the instrument.

Removing and Replacing the Battery Pack

WARNING

Do not remove or recharge the battery pack in a hazardous location.

To remove the battery pack:

1. If the instrument has been turned on, turn it off by pressing the **On/Off** key and pressing YES.
2. Use the hex key from the Tool Kit (MX380334) to loosen the four captive screws in the bottom of the battery pack.
3. Disconnect the battery pack from the instrument.
4. Replace the battery pack with a charged battery pack.
5. Clean the seal on Voyager and the rim of the battery pack of all dirt.
6. Align the connectors on the charged battery pack to the connectors at the rear of Voyager.
7. Secure the battery pack by tightening the 4 captive screws.
   Do not over-tighten the screws.

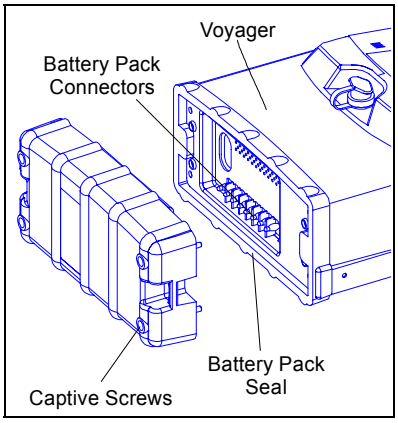


Figure 2 Removing Battery Pack

Charging the Battery Pack

NOTE: *Charging a fully discharged battery pack will take approximately 5 hours. Leaving the adapter connected to a charged battery pack will not harm the battery or the adapter in any way. If a battery pack is to be left indefinitely, leave it connected to the adapter so that it will be fully charged and ready for operation. On average, a fully charged standard battery pack will provide 4-6 hours of continuous operation. An extended life battery pack will provide approximately 6-8 hours of operation. Battery life is shorter if the instrument is turned off and then on again repeatedly and at extreme cold temperatures.*

To charge the battery pack on the Instrument:

1. Ensure the correct plug is installed on the line cord of the AC adapter.
   If it is not correct for the wall outlet in your area, then it must be replaced, as detailed in *The AC Adapter Line* Cord on page 445.

2. Plug the adapter into the jack located on the instrument.

3. Plug the adapter into an AC outlet.

4. Switch on the power at the AC outlet.
   The LED, on the instrument, indicates the charge state. Red indicates the battery is being quick charged. Green indicates the battery is fully charged and ready for use and is being trickle charged.
   It is normal for a fully charged battery to indicate it is charging (red light) when first plugged in. The LED will turn green as the battery charges. The LED is off if the AC adapter is not connected to Voyager.

5. When the battery pack is fully charged, remove the adapter, first from the AC outlet then from the battery pack.

To charge the battery pack independently of the instrument:

1. Remove the battery pack as outlined in *Removing and Replacing the Battery Pack* on page 40.

2. Plug the adapter into the jack located on the battery pack.

3. Plug the adapter into an AC outlet.

4. Switch on the power at the AC outlet.

   The LED, on the instrument, indicates the charge state. Red indicates the battery is being quick charged. Green indicates the battery is fully charged and ready for use and is being trickle charged.

   It is normal for a fully charged battery to indicate it is charging (red light) when first plugged in. The LED will turn green as the battery charges. The LED is off if the AC adapter is not connected to Voyager.

5. When the battery pack is fully charged remove the adapter, first from the AC outlet then from the battery pack.

6. Install the battery pack back onto the instrument as required.

Carrier Gas

It is advisable to obtain a large cylinder of carrier gas, from which Voyager can be operated directly or from which the internal carrier gas cylinder can be refilled.

- Carrier gas - Specify high purity nitrogen, containing less than 0.1 part per million (ppm) of hydrocarbon contamination. Nitrogen of this quality is referred to as Ultra High Purity and is available commercially. Specify a CGA 580 outlet on the tank.

  Your assay may require air. Specify high purity air, containing less than 0.1 ppm of hydrocarbon contamination. Such air is usually referred to as Ultra Zero, or Zero Zero grade and is available commercially. Specify a CGA 590 outlet on the tank.

NOTE: *You must use nitrogen if you are using the ECD.*

- Carrier Gas Filling Station - MX380303 for nitrogen or MX380319 for air.

- Carrier gas regulator - Specify a two stage, high purity regulator with a CGA 590 connection for air or, a CGA 580 connection for nitrogen. The regulator should also have a 1/8", parallel, compression fitting with which to connect the regulator to Voyager. The delivery pressure must be adjustable to 100 psig.

  A stainless steel diaphragm regulator should be used as this will reduce the potential for the carrier gas to be contaminated by the regulator itself.

  The regulator must be absolutely clean and free from any oil or other contamination. Teflon® or stainless steel tubing should be used to connect the regulator to Voyager.

NOTE: *Never use vinyl or rubber tubing to connect the regulator to Voyager, as these materials will result in contamination of the system.*

Filling the Internal Cylinder

WARNING

Do not refill the internal cylinder in a hazardous location.

If Voyager is to be used in the field, the internal cylinder will supply the carrier gas. The internal cylinder will provide approximately 8 hours of operation. The exact duration will depend on the carrier gas flow rates.

NOTE: *To avoid system contamination, do not allow the cylinder to empty completely.*

To refill this cylinder, a carrier gas filling station (MX380303 for nitrogen or MX380319 for air) is required.

WARNING

Do not attempt to fill the internal cylinder without a carrier gas filling station.

The carrier gas filling station consists of an adapter fitting with a left or right-handed thread for cylinder attachment, a three-way valve and a flexible hose. The three-way valve can be positioned to deliver gas from the cylinder through the flexible hose to the refill port. Alternatively, the valve can be turned to release carrier gas held in the hose, after filling. A pressure release valve is provided for safety at the upper end of the flexible hose. This is set at 1500 psig. A flow restrictor is also incorporated in line with the hose in order to limit the rate of escape of gas.

WARNING

Do not modify or disassemble the carrier gas filling station. If you have any problems, the unit must be returned to PerkinElmer Photovac for repair or replacement.

To fill the internal cylinder:

1. Connect the filling station fitting to the gas cylinder.
   You must specify a CGA 590, or CGA 580 when ordering the filling station.

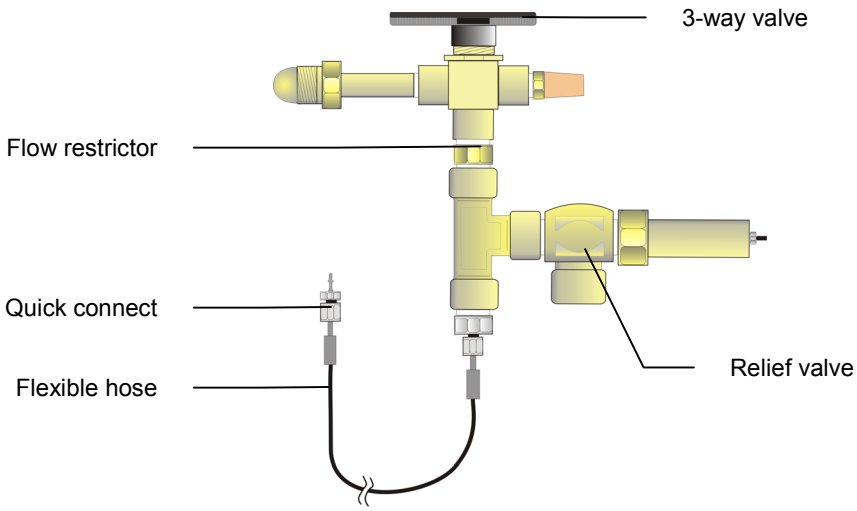


Figure 3 Carrier Gas Refill Adapters (CGA 590 and CGA 580)

2. Turn the filling station valve handle so that it points away from the cylinder.
3. Open the cylinder valve and check that there are no leaks.
4. Place Voyager on a sturdy flat surface within easy reach of the flexible filling hose.

5. Turn the filling station valve so that it points towards the cylinder.

   A steady flow of gas will be heard escaping from the end of the flexible hose. This serves to purge the hose of any impurities.

6. Return the filling station valve to point away from the cylinder.

7. Hold the knurled collar of the Voyager refill port and slide it down towards the top panel.

8. Insert the fitting at the end of the flexible hose into the refill port until it seats against the port.

   You will hear a click.

9. Release the knurled collar and allow it to slide up to its original position.

10. Turn the filling station valve so that it once again points towards the cylinder and watch the pressure increase on the cylinder contents gauge on Voyager's side panel.

WARNING

Do not leave Voyager unattended while filling the internal cylinder.

NOTE: *When the cylinder contents indicates approximately 1500 psig, the pressure relief valve on the filling station will begin venting and prevent any further increase. The contents pressure indicated MUST NOT exceed 1800 psig and the 3-way valve should be switched before this occurs.*

11. Turn the filling station valve handle to point away from the cylinder to allow high pressure gas trapped in the flexible hose to escape.

    A check valve in Voyager prevents gas in the cylinder from escaping.

12. Close the gas cylinder valve.

13. After relieving the gas pressure in the hose, remove it from the refill port by pulling the knurled collar down and extracting the fitting.

14. If the cylinder was empty, you will need to flush it through by emptying it again, see *Purging the Internal Carrier Gas Cylinder* on page 266, and then filling it again

Connecting Carrier Gas

Voyager may be connected to an air or nitrogen cylinder for continuous operation. A two-stage, high purity regulator capable of delivering 100 psig is required. Use the carrier gas connection kit (MX380309)

1. Connect compression fittings to both ends of a length of the 1/8" Teflon tubing.

2. Set the external carrier delivery pressure to 100 psig (690 kPa).

3. Purge the Teflon tube to remove any contamination.

4. Plug the Quick Connect into the refill port on Voyager.

   A continuous pressure of carrier gas must be maintained, even when the instrument is not in use. This ensures Voyager is ready for use at short notice and prevents column contamination.

NOTE: *The internal cylinder will empty until it is at the same pressure as the pressure being delivered from the tank. The contents gauge may show 0 psi when Voyager is operated from an external cylinder.*

Connecting Accessories

Personal Computer running SiteChart Software

In order to utilize all of Voyager's features you will need to use the SiteChart software. To do this you must connect Voyager to a compatible PC and set up the instrument from the PC. Complete specifications for the required PC and details on connecting the PC to Voyager are covered in *SiteChart Software* starting on page 99.

DC Power Cord

Voyager can be connected to a car battery through the cigarette lighter with the DC power cord (MX380313).

NOTE: *If the car is running you must ensure the car exhaust does not interfere with the samples.*

WARNING

Do not connect the DC power cord to Voyager in hazardous locations.

1. Turn the instrument off.
2. Connect the DC power cord (MX380313) to Voyager AC adapter port.
3. Connect the other end of the DC power cord to the cigarette lighter in the car.
4. Turn the instrument on again.

NOTE: *For extended operation, you should use a fully charged battery pack (MX380315).*

Carrying Strap

Use the carrying strap (Part No. MX380308) for field operation to facilitate single-handed operation.

1. Snap one end of the carrying strap to one connector on Voyager.
   Voyager has four connection points for the carrying strap.
2. Snap the other end of the carrying strap to another of the connectors on the instrument.
   The connection point is selectable to suit your application.
3. Adjust the shoulder pad and strap length for comfort.

Carrying Harness

Use the carrying harness (MX380312) for field operation to facilitate hands-free operation. The carrying harness can be used to carry the instrument on the front or back of your body.

1. Place one shoulder pad over each shoulder.
2. Tighten the belt abound your waist.
   Ensure no straps are twisted.
3. Connect Voyager to the shoulder straps first.
4. Connect the waist straps to Voyager.
5. Adjust the waist belt, shoulder straps and shoulder pads for comfort.

Telescoping Sample Probe

A two meter (6’), telescoping, extension probe (MX380311) may be connected to the Voyager sample in port for remote sampling. The probe can be mounted to the side of the instrument to facilitate portable operation.

WARNING

Do not connect the mounting clips to Voyager in hazardous locations.

Connecting the Probe

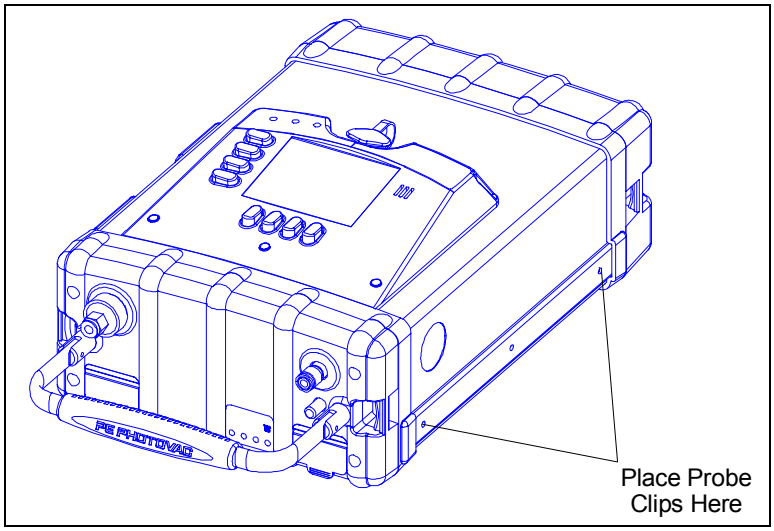


Figure 4 Placement of Plastic Probe Clips

1. Remove the screw located below the carrier gas contents gauge.

2. Install the plastic clip to Voyager using one of the screws provided with the probe.

3. Remove the middle screw and install the clip.
   Keep the screws that you removed in the sample probe bag.

4. Tighten the screws down to ensure the Voyager case is securely closed.

5. Connect the probe to Voyager's sample in port. Use the compression fitting supplied with the probe.

Using the Probe

- To extend the probe, loosen the knurled nut at the top of the wand, pull the extension out and then tighten the knurled nut to lock the extension in place.

- To lengthen the probe further, loosen the lower knurled nut, pull the second extension out and then tighten the knurled nut to lock the extension in place.

- To reduce the probe, loosen both knurled nuts and push the extensions back into the probe, then tighten the knurled nuts down to lock the extensions in place.

CAUTION	*When using the telescoping sample probe, NEVER aspirate liquids or solids as they will damage the instrument.*

Removing the Probe

1. Turn Voyager off.

2. Disconnect the probe from Voyager's sample in port.

3. Remove the mounting clips.

4. Replace the original screws in Voyager's case.

5. Tighten the screws down to ensure the Voyager case is securely closed.
   Do not over tighten these screws.

WARNING

You must replace the screws in Voyager's case. You will impair the intrinsic safety rating if these screws are not installed and tightened into the case.

Connecting the Filter to the Telescoping Sample Probe

You can install a filter on the end of the probe to ensure liquids and solid materials are not aspirated into the telescoping sample probe and then to the instrument.

1. The filter connector (MX380340) connects the filter to the inlet tubing of the probe. The connector has a 3/16" port for the inlet tubing of the probe and a 1/4" port for the filter. Press the inlet tubing of the probe into the connector until it is locked in place.

2. Press the narrower end of the filter into the other end of the connector until the filter is locked in place.

Replacing the Filter

The filter will remove airborne particulates for up to 4 hours. The operating environment will determine the exact time. The pump will sound labored when the filter requires replacement.

1. Press the narrow collar on the connector in, toward the connector.
   This will release the filter. If you cannot depress the collar with your finger then use the multi-tool to depress the collar.

2. Remove the used filter.

3. Insert the new filter (MX380339) into the collar until the filter is locked in place.

   When the filter is not in use, place it in its plastic bag and store it in a clean, dry place.

Three Meter Sample Line

For remote sampling or for sampling a location that is difficult to reach, use the three meter sample line (MX380305).

1. Connect the three meter sample line to Voyager's sample in port.

2. Place the other end of the sample line at the sampling location.

CAUTION	*When using the telescoping sample probe, NEVER aspirate liquids or solids as they will damage the instrument.*

Field Check List

The following items should be carried into the field to reduce or eliminate instrument down time. If you will be in the field for a single 8-10 hour day, you should include the following accessories:

	Description	Part No.
❑	Battery pack (spare)	MX380314 or MX380315
❑	Calibration gas tank	Not applicable
❑	Regulator to fit calibration gas tank	Not applicable
❑	Calibration gas flow adapter	MX380328
❑	Calibration kit(s)	MX380310 or MX380337
❑	Carrying harness	MX380312
❑	Carrying strap	MX380308
❑	DC adapter	MX380313
❑	Extension sample probe filter (10)	MX380339
❑	3 L Gas bag (for zero air)	60062801
❑	Gas bag adapter	MX396010
❑	Sample inlet filter (25)	MX396015
❑	Septa (spare)	MX380306
❑	Septum capped vials	MX600629
❑	Syringe	60063101
❑	Telescoping sample probe	MX380311
❑	Three meter sample line	MX380305
❑	Tool kit	MX380334
❑	Transit case	MX380316
❑	User's Guide	MX380301
❑	User's reference card	MX380335
❑	UV lamp (spare)	MX380029
❑	UV lamp window cleaning kit	MX380336

If you will be in the field for more than one day you may want to include the following additional items:

	Description	Part No.
❑	AC adapter	MX380302, MX380330 or MX380331
❑	Carrier gas and filling station	MX380303 or MX380319
❑	PC and associated cables	Not applicable
❑	Communication cable kit	MX380304
❑	SiteChart software	MX380307 or MX380342

Storing Voyager

When storing Voyager, the following conditions must be maintained:

- You must maintain a flow of carrier gas through the columns to prevent contamination. Fill the internal cylinder or connect an external supply of carrier gas.

- Do not allow the internal cylinder to empty completely. The internal cylinder and the columns will become contaminated.

  If the internal cylinder is completely empty when you come to use the Voyager you must first purge the internal carrier gas cylinder, see page 266, and then flush the column after filling the instrument with carrier gas. Allow the instrument to warm up for 30 minutes. Monitor the offset level as displayed on the status screen and wait until it has stabilized before attempting to use the instrument. An instrument that is cleaning out, will show an unstable and dropping baseline. Typical offset is in the range 200-800 mV and anything over 800 mV indicates contamination.

- Store Voyager in a location that is free of volatile organic vapors and gases. The ambient temperature must be above 0 °C (32 °F) and below 40 °C (105 °F).

- If the battery pack has been discharged, connect the instrument to the AC adapter and recharge the battery.

Your operating requirements will determine the method that you use to store Voyager. The following sections list Voyager availability and the preferred method of storage.

Immediate Availability

If you use Voyager every day, you will most likely want the instrument ready to use immediately. If you do not use the instrument regularly, but still require immediate availability then you must store the instrument as described below.

- Leave Voyager turned on.
- Calibrate once every 24 hours.
  Calibration should be performed before beginning operation of Voyager, as noted in *Calibration* on page 223.
- Connect the instrument to a carrier gas cylinder, or refill the carrier gas cylinder every 6 - 8 hours.
- Connect the instrument to the AC adapter when not is use.

Availability Within 30 Minutes

If you use Voyager less frequently, you may want to use the following procedure for storing the instrument. This procedure allows you to store the instrument up to 5 days. When you are ready to use Voyager, allow approximately 30 minutes for the instrument to warm up. Better analysis result may be obtained if you allow the instrument to warm up for 1-2 hours.

- Turn Voyager off.
- Connect the instrument to an external cylinder of carrier gas.
- Connect the instrument to the AC adapter.

➢ When you are ready to use Voyager, turn it on and allow 30 minutes for the instrument to warm up and stabilize. When all faults have cleared, calibrate Voyager for your application.

Availability Within 12 Hours

To store the instrument for extended periods use the following procedure. When you are ready to use the instrument, allow approximately 12 hours for the instrument to stabilize.

- Turn Voyager off.
- Connect the instrument to an external cylinder of carrier gas.
- Connect the instrument to the AC adapter.

➢ When you are ready to use Voyager, turn it on and leave at least 12 hours for the instrument to stabilize. Allow the column to flush overnight until the offset level returns to 200-800 mV.

Using Voyager 3

Introduction

This chapter discusses basic operation of Voyager. Voyager is a menu based system. Four menus contain all the functions to control the operation of the instrument.

By working through this chapter, you will familiarize yourself with the basic operation of the instrument.

User and Supervisor Modes

In order to customize the user interface for both simplified field operation and at the same time retain the powerful chromatographic features, Voyager supports two modes of operation: user mode and supervisor mode.

In user mode, some of the more advanced features are hidden. This simplifies operation of the instrument for field use.

In supervisor mode, all the user mode commands are available and advanced method development features are accessible.

A password is required to change from user mode to supervisor mode. The password is factory set to 12344321 and cannot be changed.

Fixed Keys

The four keys, located to the left of the display, each have a fixed function and are called the fixed keys. The top key is the **On/Off** key, the next key is **Start Stop**, the third key is **Enter Menu** and the bottom key is **Exit**.

- The **On/Off** key is used to turn Voyager power on and off. You will be prompted before the instrument shuts down to prevent accidental power off.

- The **Start Stop** key starts or stops a GC or TVOC analysis.

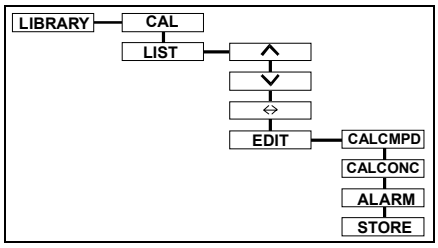
- The **Enter Menu** key has a context sensitive function. When you are navigating through the function map, press the **Enter Menu** key to exit the function map and remove the menu from the display. When entering data, **Enter Menu** is used to confirm the entry.

- The **Exit** key provides a way of returning to a previous display or exiting the function map completely. Press the **Exit** key to move back through the function map.

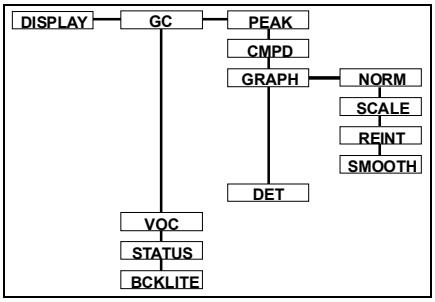
Soft Keys

The four keys, located directly below the display, each have varying functions depending on the menu displayed. These soft keys are used for configuring Voyager, editing the datalogger, and controlling the display. Since only four soft keys are available, each function is broken down into a path. Maps, showing each path and the resulting functions, are shown in below.

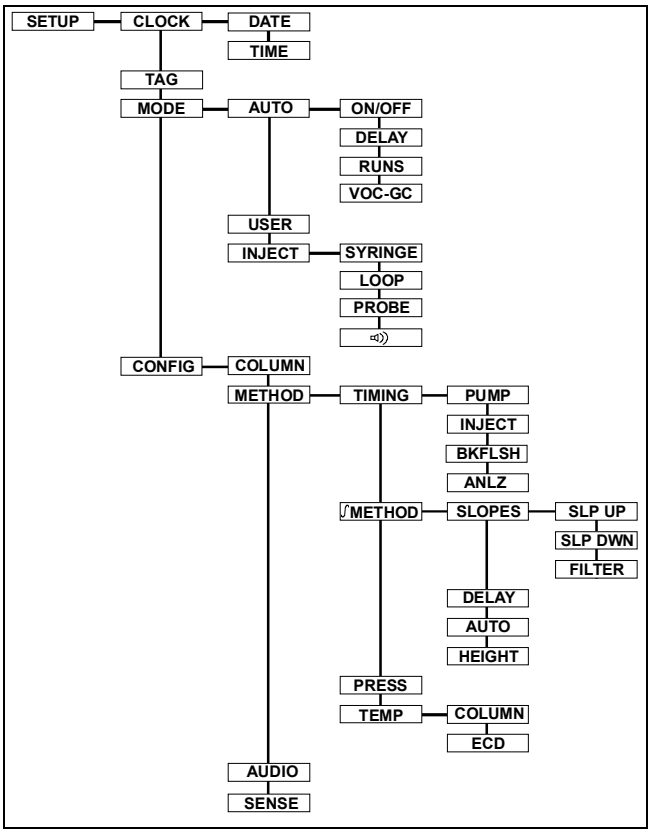
GC Supervisor Mode - Library Key



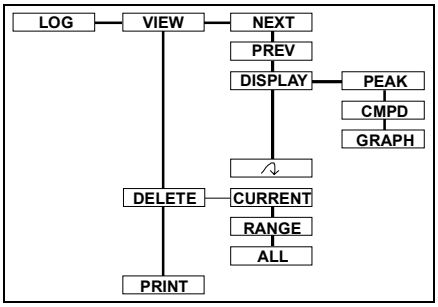
GC Supervisor Mode - Display Key



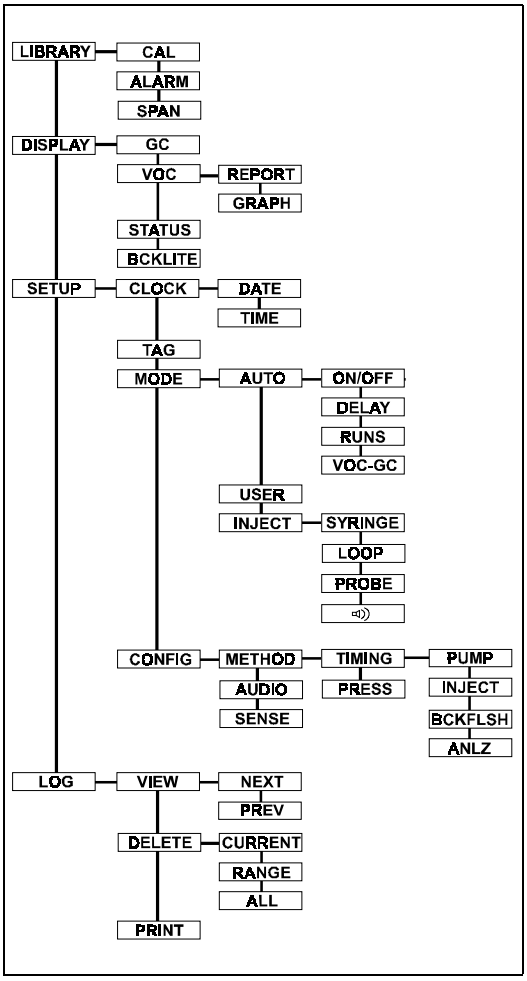
GC Supervisor Mode - Setup Key



GC Supervisor Mode - Log Key



TVOC Supervisor Mode - all keys



For all information that you must enter, the soft keys correspond to the up, down, left, and right arrow.

The up and down arrows are used to edit the character highlighted by the cursor. The right arrow is used to advance the cursor to the next character on the right. When the cursor is advanced to the right most character, it stops. The left arrow is used to advance the cursor to the previous character on the left. When the cursor is advanced to the left most character, it stops.

To accept the changes, press the **Enter Menu** key. To ignore the changes, press the **Exit** key.

Indicator LEDs

The indicator LEDs visually indicate Voyager's status:

- The Ready LED is lit when the run is complete, and Voyager is ready for the next sample.
- The Sampling LED indicates that a sample is currently in the column.
- The Alarm LED is lit when one or more compounds in the last analysis exceeds the preset alarm level.

Beginning Operation

1. Before beginning operation of the instrument, you must fill the internal cylinder with carrier gas or connect the instrument to an external supply of carrier gas. See *Carrier Gas* starting on page 44.

2. Ensure the battery is charged or that the instrument is connected to the AC adapter.

3. Press the **On/Off** key.
   The EPROM version and copyright notice will be displayed.

4. Press the up or down arrow to adjust the contrast, as required.
   If the display is still hard to see, you can turn the backlighting on.

To use the Backlight:

1. Press the **Enter Menu**.
   The soft keys will be shown along the bottom of the display.

2. Press the key below DISPLAY.

3. Press BCKLITE.

4. Press ON to turn the backlighting on.

5. Press **Enter Menu** to close the menu.

NOTE: *To extend the operating life of the battery pack, turn the backlighting off when it is not required.*

Status Line

The top line of the display will always be the status line. When the instrument is idle, the instrument status, the date, time, sample inlet and detector are displayed. One of four sampling options will be displayed:

Sampling Method	Status Line Code
Loop Injection	LP
Long Sample Probe	PRB
Extended Sample Probe	PRB
Syringe Injection	SYR

If a fault occurs, the top line of the display will alternate between the fault message and the status line.

When Voyager is performing a run the status line will display the instrument status, an analysis timer, the current column, the run # and detector.

If you are reviewing logged data, the status line will display the time and date the analysis was run. This information will alternate with the column and run #.

Instrument Status	Description
Alarm	Alarm condition on last run
Sample	The pump is drawing a sample
Analyze	Analysis in progress
Ready	Ready to start an analysis

Instrument Status	Description
PowerDn	Lamp turned off due to pressure fault
Over Range	Signal was over range on the last run.
Tuning	The UV lamp is being started
Wait	Displayed at the delay time during auto-cycling
Fault: Log Full	Datalogger is full
Fault: Low Batt	Battery condition is low
Fault: Lamp	Lamp intensity failure
Fault: Oven Not Ready	Oven not within +/- 1° of the set point
Fault: Pressure	Carrier pressure is low
Fault: Calibration	Bad calibration run

Setting the Date and Time

The Clock key is used to set both the current date and time.

1. Press **Enter Menu**.
2. Press the SETUP key.
   Each time you press a soft key, the soft key names change.
3. Press CLOCK.
4. Press TIME.
5. Use the arrow keys to enter the correct time.
   The time is formatted as Hour:Minute:Second.
   The up and down arrows are used to edit the character underlined by the cursor. The right arrow is used to advance the cursor to the next character on the right.
   Formatting characters, such as the colon (:) in the time and the slash (/) in the date are skipped when advancing the cursor.
6. Press **Enter Menu** to confirm the time and then press DATE.
7. Use the arrow keys to enter the correct date.
   When setting the date, format as Year/Month/Day.
8. Press **Enter Menu** to confirm the date.
9. Press **Enter Menu** again to close the menu.

Reviewing the Instrument Status

The status screen provides the current operating parameters. You cannot alter any parameters in the status screen. Each parameter is listed below with a brief description:

Parameter	Description
PID Signal	The current signal from the photoionization detector.
PID Offset	The voltage applied to keep the baseline at 10% of full scale. The applied offset is an indication of column contamination. If the offset is greater than 800 mV the column should be allowed to flush until it stabilizes at a value between 200 and 800 mV.
PID UV Int	The intensity of the lamp. The intensity is measured by a photocell and converted to a voltage. The lamp is tuned to approximately 75% of its maximum intensity and maintained at this intensity.
PID Status	Shows whether the lamp is on or off.
PID Temp	The operating temperature of the photoionization detector.
Column Temp	The current temperature of the selected column.
Ambient Temp	The temperature as measured by a sensor inside Voyager.
Pressure	The column head pressure.
Active Column	The column selected for the current analysis.
Log Capacity	The amount of space remaining in the datalogger.
Battery	The battery voltage.

Parameter	Description
Charge State	If the instrument is connected to the AC adapter the charge state will be Fast if the battery pack is being charged or Trickle if the battery pack is being maintained at full charge. If the instrument is operating from the battery pack alone then the charge state will be Off.
Serial #	The serial number of the instrument.
Cycle Time	This timer shows the time remaining in the current analysis. If a run is not in progress, then this parameter is set to 0.

If the ECD is selected for operation, then parameters specific to the ECD will be displayed.

To change the view from the PID to the ECD:

1. Press DISPLAY, then STATUS, then GC, then DET.
2. When prompted to change views to the ECD, press **Enter Menu**.

Parameter	Description
ECD Signal	The current signal from the electron capture detector.
ECD Offset	The voltage applied to keep the baseline at 10% of fullscale. The applied offset is an indication of column contamination. If the offset is greater than 800 mV the column should be allowed to flush until it stabilizes at a value between 200 and 800 mV.
ECD Status	Shows that the ECD is on or off.
ECD Temp	The operating temperature of the electron capture detector. The temperature can be set independently of the column and PID.

Display Options

- Switch between display options by pressing **Enter Menu** and then DISPLAY and GC.

  PEAK will list all the peaks in the current or last analysis. If a peak matches a library compound it will be identified. If the retention time does not correspond to a library compound it will be listed as Unknown.

  CMPD (Compound) lists all the compounds in the current library. If the compound is present in the current or last analysis, a concentration and status will be listed beside the compound.

  GRAPH shows the chromatogram as it develops. As peaks appear and are integrated they are numbered. You can normalize the chromatogram or view the full scale.

  DET is used when an ECD is installed, and switches to display the output from the second detector. If you have selected both PID and ECD operation then you can use this option to switch between views.

- To normalize the graph press **Enter Menu**, DISPLAY, GC, GRAPH and NORM.

  This will adjust the scale so that full scale is the top of the largest peak.

- Selecting SCALE will return to the display to the full range of 0-2500 mV at high sensitivity or 0-252 mV at low sensitivity.

Compound Status Codes

Code	Description
OK	Detected concentration is within acceptable concentration limits.
A1	Exceeded alarm concentration
C	Displayed when you have used the run for calibration. Indicates that the compound was used for calibration.

Code	Description
CR	Indicates a compound that was present in the library but not contained in the calibration gas. This method of calibration may lead to an invalid calibration and is intended for specialized applications only. Please contact the PerkinElmer Photovac Applications Department for more details.
CF	This compound was selected for calibration but was not present in the calibration gas. A calibration fault was encountered during calibration.
OV	The peak has gone over range. The peak will be extrapolated based on where the signal went off scale and where it returned. The displayed concentration will be derived from the extrapolated peak area.

Entering a Tag

A tag may be used to identify certain sampling location or a certain sample in the datalogger. You can enter a tag to indicate a change of location or a change in personnel.

To enter a tag:

1. Press **Enter Menu** then SETUP and TAG.
2. Use the arrow keys to enter a name or number.
   The tag can use up to 10 characters.
3. Press **Enter Menu** to confirm the tag.
4. Press **Enter Menu** to close the menu.
   The tag you enter here will identify both GC and TVOC analyses. You can enter a new tag for every analysis or you can enter a single tag for a group of analyses.
   A pop up box will prompt you to enter a tag when you begin the first run after the instrument has been turned on.

Audio Options

Alarm Audio

If any of the identified peak concentrations exceed the alarm level, stored in the library, then the audible alarm may sound at the end of the analysis.

You have three options for the audio alarm. You can turn it off and there will be no audible indicator if an alarm occurs. Turn the audio off if you are auto-analyzing or if you are controlling Voyager from a remote location through SiteChart. You can turn the audio alarm on, so an audible alarm will sound until the alarm is acknowledged. You can also set the alarm to sound momentarily and then shut off.

To change the audio option:

1. Press **Enter Menu**, then SETUP, CONFIG, and AUDIO.

2. Use the arrow keys to select the desired option from the Set Audio box and press **Enter Menu** to confirm your selection.

3. Press **Enter Menu** to close the menu.

Injection Audio

You can configure Voyager to sound an audible indicator when the sample is injected onto the column. This injection beep is most useful for syringe injections.

1. Press **Enter Menu**, then SETUP, MODE, and INJECT.

2. Press the speaker icon.

3. Use the arrow keys to select off and press **Enter Menu** and then **Exit**.

Loop Injection Analysis

The instrument will be set up according to the method loaded on your instrument. You can use a PC and the SiteChart software to load another method.

Selecting the Injection Method

Voyager can accept both manual syringe and automatic sample loop injections. You must calibrate using the same injection technique as your sample. If you are using automatic loop injection for sampling, calibrate using loop injection. If you are using syringe injection for sampling, calibrate using syringe injection.

To select the injection method:

1. Press **Enter Menu**, then SETUP, MODE, and INJECT.

2. Press LOOP and press **Enter Menu** to set the option and to close the menu.

   The sampling method will be indicated in the status line as LP to indicate a loop injection or PRB to indicate a loop injection through either the long probe or the extended probe.

Performing a Loop Injection Analysis

1. Ensure carrier gas is supplied to the instrument.

2. Ensure the plugs have been removed from the following ports: Detector 1 and 2 out, pump out and vent out.

3. Monitor the offset level in the status display box.

   If it is above 800 mV or if the offset level is falling, allow the instrument to stabilize for about an hour. If this does not bring the signal down, flush the column for a few hours or overnight, as described in *Flushing the Columns* starting on page 263.

NOTE: *If you are using the ECD, you will also need to monitor the ECD offset level. Press DISPLAY, STATUS, GC, and DET. When prompted to change views to the ECD, press* **Enter Menu**. *Monitor the offset level in the status display box. If it is above 800 mV or if the offset level is falling, allow the instrument to stabilize for about an hour. If this does not bring the signal down, flush the column for a few hours or overnight.*

4. Disable automatic analyzing by pressing **Enter Menu**, then SETUP, MODE, AUTO, and ON/OFF. Use the arrow keys to select Off and then press **Enter Menu**. Press **Exit** to close the box. Press **Enter Menu** to close the menu.

5. During a loop injection, Voyager will draw a sample through the sample in port. Connect a gas bag containing some calibration gas to the sample in port. A gas bag is included in the Calibration Kit (MX380310 or MX380337).

6. Once the bag is connected, press **Start Stop**. If prompted to enter an analysis tag, press YES and use the arrow keys to enter TEST. Press **Enter Menu** to confirm the entry and start the analysis.

   When the analysis starts, a message will be displayed indicating which column and detector will be used. You will hear a beep when the sample is injected on to the column.

   The status line will now show a timer, a run number, the column and detector in use. If you are in peak display, peaks will be added to the list as they are integrated. If you are in compound display, concentrations of detected peaks will be updated at the end of the analysis. In graph display, you can see the chromatogram developing. Another line displays the fullscale range and the analysis time.

Peaks are identified depending on what information is in the current library. If any of the identified peak concentrations exceed the alarm level, stored in the library, then the audible alarm may sound at the end of the analysis.

- If an alarm is encountered, an alarm acknowledge box will open, press YES to acknowledge the alarm condition and to silence the audible alarm.

Setting Probe Length

If you are doing a loop injection you can choose one of two sample probes or no probe at all.

NOTE: *If you are using the long probe or the extended probe you must allow for a longer pump time so that the sample can be drawn through the sampling probe. The pump time is set automatically when you select the probe.*

To set the probe length:

1. Press **Enter Menu** then SETUP, MODE, and INJECT.

2. Press PROBE and use the up and down arrow keys to select the desired probe.

   Select short if you are not using a probe or if you are using the gas bag adapter. The long sample line is 3 meters (m) long. The telescoping extended sample probe is 5 m long and has a telescoping handle.

3. Press **Enter Menu** to confirm your selection, press **Exit** to close the box and return to the menu, and press **Enter Menu** to close the menu.

Performing a Syringe Injection Analysis

Selecting the Injection Method

Voyager can accept both manual syringe and automatic sample loop injections. You must calibrate using the same injection technique as your sample. If you are using automatic loop injection for sampling, calibrate using loop injection. If you are using syringe injection for sampling, calibrate using syringe injection.

To select the injection method:

1. Press **Enter Menu**, then SETUP, MODE, and INJECT.

2. Press SYRINGE and press **Enter Menu** to set the option and to close the menu.

   The sampling method will be indicated in the status line as SYR.

Performing a Syringe Injection Analysis

1. Ensure carrier gas is supplied to the instrument.

2. Ensure the plugs have been removed from the following ports: Detector 1 and 2 out, pump out and vent out.

3. Monitor the offset level in the status display box.

   If it is above 800 mV or if the offset level is falling, allow the instrument to stabilize for about an hour. If this does not bring the signal down, flush the column for a few hours or overnight, as described in *Flushing the Columns* starting on page 263.

NOTE: *If you are using the ECD, you will also need to monitor the ECD offset level. Press DISPLAY, STATUS, GC, and DET. When prompted to change views to the ECD, press* **Enter Menu**. *Monitor the offset level in the status display box. If it is above 800 mV or if the offset level is falling, allow the instrument to stabilize for about an hour. If this does not bring the signal down, flush the column for a few hours or overnight.*

4. Disable automatic analyzing by pressing **Enter Menu**, then SETUP, MODE, AUTO, and ON/OFF. Use the arrow keys to select Off and then press **Enter Menu**. Press **Exit** to close the box. Press **Enter Menu** to close the menu.

5. Flush a 100 uL syringe with sample and then draw a 100 uL sample.

CAUTION	*Only inject gas samples into the Voyager. Injection of liquid or solid samples will damage the Voyager.*

6. When the syringe is ready press **Start Stop**. If prompted to enter an analysis tag, press YES and use the arrow keys to enter TEST. Press **Enter Menu** to confirm the entry and start the analysis.

7. The amount of time to make the injection will depend on the pump time set during method development.

   A count down timer in the status line will show the time for you to prepare for the injection.

8. Guide the syringe needle through the hole in the injection port until the needle point touches the septum, but do not pierce the septum or depress the plunger.

9. After the beep, push the needle though the septum until the barrel comes up against the injection port and immediately depress the plunger.

   Depressing the plunger must be a rapid movement.

10. Leave the syringe in place for about 2 seconds then withdraw it.

    When the analysis starts, a message will be displayed indicating which column and detector are in use.

    The status line will now show a timer, a run number, the column and detector in use. If you are in peak display, peaks will be added to the list as they are integrated. If you are in compound display, concentrations of detected peaks will be updated at the end of the analysis. In graph display, you can see the chromatogram developing. Another line displays the fullscale range and the analysis time.

The manual injection technique described above will give varying results at first. Practice making manual injections until the results can be reproduced to within 5% of the integrated peak area.

Peaks are identified depending on the information in the current library. If any of the identified peak concentrations exceed the alarm level, stored in the library, then the audible alarm may sound at the end of the analysis.

- If an alarm sounds, an alarm acknowledge box will open. Press YES to acknowledge the alarm condition and to silence the audible alarm.

NOTE: *While an analysis is in progress it is not possible to change to TVOC mode. Wait until the current analysis is complete before attempting to change modes.*

- To stop the analysis before it is complete, press the **Start Stop** key.

  If you stopped the analysis after the sample was injected onto the column you must wait for the duration of the analysis time for the column to be flushed before beginning another analysis on the same column, otherwise carry-over my result. When you stop an analysis, Voyager will begin to flush the column and move to the next column. When you press **Start Stop**, the analysis will begin on the next column.

NOTE: *If you are using syringe injection, you must calibrate Voyager using syringe injection.*

Automatic Operation

Automatic operation allows you to set up Voyager to sample unattended. If more than one column is required to complete an analysis, then each column will be sampled in order. If each column has different chromatographic settings, Voyager will adjust its settings between analyses. You can also configure the instrument to perform a preset number of analyses. You must use loop injections for automatic analyzing.

1. Ensure the battery is fully charged or connect the instrument to the AC adapter, as discussed in *Battery Pack* on page 40.

2. Fill the carrier gas cylinder or connect the instrument to a tank of carrier gas as discussed in *Carrier Gas* on page 44.

3. Calibrate the instrument before beginning automatic operation, see *Calibration* starting on page 223 for calibration procedures.

4. If you are running continuously then clear the datalogger.

   OR

   If you are running a preset number of analyses you can clear the datalogger or ensure there is enough free space for the number of analyses you are about to run.

5. Press **Enter Menu**, then DISPLAY, GC and GRAPH.
   If you prefer, select a different display option.
   You will now setup Voyager to perform GC analyses.

6. Press **Enter Menu**, then SETUP, MODE, AUTO.

7. Press DELAY and use the arrow keys to enter a delay time.
   This is the time between runs.

8. Press **Enter Menu** to confirm the entry and close the box.

9. Press RUN and use the arrow keys to enter the number of analyses required.
   If your method requires all three columns and you need 2 complete analyses, enter 6. After 6 runs, 2 on each column, Voyager will turn automatic analyzing off. If you want the instrument to sample continuously enter 0.
   Zero is the default value.

10. Set a minimum of 1 minute delay between runs to enable Voyager to stabilize the baseline between runs.

11. Press **Enter Menu** to confirm the entry and close the box.

12. Press ON/OFF (the soft key) and use the arrow keys to select On and then press **Enter Menu** to confirm the selection.

13. Press **Exit** to close the box.
    Voyager will begin a run on Column A, B or C.

Voyager will now run continuously until it has performed 6 runs. If you have set the instrument to run continuously it will run until it encounters a critical fault such as a lamp failure, low battery or carrier gas pressure fault.

NOTE: *If you want to begin analyzing on a certain column you must press **Start Stop** to begin an analysis and then press **Start Stop** again to stop the analysis and move to the next column. For example if the last analysis was performed on Column B and you want to start automatic analyzing on Column A, press **Start Stop**. The run begins on Column C. Press **Start Stop** before the pump stops. This will abort the run before the injection is made onto Column C and prepare for the next run on Column A.*

TVOC Analysis

You can use the TVOC mode to screen a sample for total volatile organic compounds. If a preset alarm is exceeded you can then use the GC to determine which compounds are present. A TVOC sample may be injected by syringe or you may use loop injection. The injection is directed to Column V. Column V is a blank column. The sample passes through the column, without separating, and into the detector.

NOTE: *A TVOC analysis is sent through the PID only. You cannot obtain a TVOC run through the ECD.*

TVOC Method

You configure Voyager for a TVOC run in the same manner as you would for a GC run. The methods you receive on the assays disk will not normally contain a method for TVOC operation. You can use the same settings as the GC or you can configure the TVOC for the shortest possible analysis time.

1. Press **Enter Menu**, then DISPLAY, VOC and REPORT (or GRAPH).

2. Check the status line to ensure you are set up for the correct type of injection.
   A status of LP indicates a loop injection. PRB indicates a loop injection using the long or extended probe. If SYR are shown on that status line, Voyager is expecting a syringe injection. Refer to *Selecting the Injection Method* on page 78 or 81 if you need to change it.

3. Press **Enter Menu**, then SETUP, CONFIG, METHOD, TIMING and PUMP.

4. Enter a pump time and press **Enter Menu.**

5. Press INJECT and enter the injection time.

6. Press BKFLSH and enter the backflush time.

   In TVOC operation the backflush time is only used for syringe injections. Backflushing and can reduce peak tailing due to the injection port. Backflushing of the injection port begins at the backflush time.

   The sample will clear the column in approximately 30 seconds, The exact time will depend on the pressure and resulting column flow rate. You must then backflush the column to ensure any sample residue is removed from the chromatographic system. Set the back flush time to equal the retention time of the unretained sample.

7. Press **Enter Menu** to confirm the entry.

8. Press ANLZ and enter the analysis time.

   An analysis time of 60 seconds can be used for most applications. If you are using syringe injection, set the analysis time so that it includes the sample transit time (retention time) and the backflush time. If the sample clears the column in 30 seconds, then the backflush time has also been set to 30 seconds and the resulting analysis time will be 60 seconds (30+30).

9. Press **Enter Menu** to confirm the entry.

10. Press **Exit** and then PRESS and enter a pressure setting.

    Set the pressure to the same value used in your GC method to reduce the time between runs.

    If necessary you can operate the TVOC at 14 psi. This will increase sensitivity and reduce the TVOC analysis time allowing faster TVOC cycling. If the TVOC and GC methods contain different pressure settings, Voyager must stabilize for 20-30 minutes between runs. You may lose any time gained by increasing the TVOC pressure.

11. Press **Enter Menu** to confirm the entry.

12. Press **Exit** then press SENSE and enter the desired detector sensitivity.

13. Press **Enter Menu** to confirm the entry and then press **Exit**.

NOTE: *The column temperature will be set by the GC method for last active column.*

Performing a TVOC Run

1. Press **Enter Menu**, then DISPLAY, VOC and REPORT (or GRAPH).

2. Press **Start Stop**.
   The analysis will start and a box indicating a run on Column V (the VOC column) will be displayed.

NOTE: *If you are performing a syringe injection, make sure Voyager is configured for a syringe injection and prepare the syringe sample before you press* ***Start Stop****. The analysis will start and you will have 10 seconds to make the injection. A count down timer in the status line will show the time for you to prepare for the injection. Guide the syringe needle through the hole in the injection port until the needle point touches the septum, but do not pierce the septum or depress the plunger. After the beep, push the needle though the septum until the barrel comes up against the injection port and immediately depress the plunger. Depressing the plunger must be a rapid movement.*

CAUTION

Never inject liquid or solid samples into the Voyager, you will damage the instrument.

NOTE: *The number displayed is not a real time reading. The display value will be updated at the end of the TVOC analysis. The status line now shows a timer, a run number, the column and detector in use. A bar showing the progression of the analysis is also displayed. A status of "OK" is shown beside the numerical value. See* Status Line *on page 69 for other possible status messages.*

3. Press **Enter Menu**, then DISPLAY, VOC and GRAPH.

   Selecting GRAPH shows you a graph of response versus time. This is a real time display. A single peak on the graph indicates the presence of VOCs. In graph display, another line of text displays the fullscale range and the analysis time.

   At the end of the TVOC analysis, if any VOCs were present, the area of the TVOC peak will be shown at the bottom of the Report display.

NOTE: *If the detected concentration exceeds the alarm level, stored in the library, then the audible alarm may sound at the end of the analysis. If an alarm sounds, an alarm acknowledge box will open. Press* YES *to acknowledge the alarm condition and to silence the audible alarm.*

NOTE: *While an analysis is in progress it is not possible to change to GC mode. Wait until the current analysis is complete before attempting to change modes.*

- To stop the analysis before it is complete, press the **Start Stop** key.

  If you stopped the analysis after the sample was injected onto Column V, you must wait for the duration of the analysis time for the column to be flushed before beginning another analysis.

TVOC Automatic Operation

1. Ensure the battery is fully charged or connect the instrument to the AC adapter, as discussed in *Battery Pack* on page 40.

2. Fill the carrier gas cylinder or connect the instrument to a tank of carrier gas as discussed in *Carrier Gas* on page 44.

3. Calibrate the instrument before beginning automatic operation, see *Calibration* starting on page 223 for calibration procedures.

4. If you are running continuously then clear the datalogger.

   OR

   If you are running a preset number of analyses you can clear the datalogger or ensure there is enough free space for the number of analyses you are about to run.

5. Press **Enter Menu**, then DISPLAY, VOC and GRAPH.
   If you prefer, select the REPORT display option.

6. Press **Enter Menu**, then SETUP, MODE, and AUTO.

7. Press DELAY and use the arrow keys to enter a delay time.
   This is the time between runs.
   A minimum of 1 minute is required to allow the Voyager to stabilize the baseline.

8. Press **Enter Menu** to confirm the entry and close the box.

9. Press RUN and use the arrow keys to enter the number of analyses required.
   If you want the instrument to sample continuously enter 0, which is the default value.

10. Press **Enter Menu** to confirm the entry and close the box.

11. Press ON/OFF (the soft key) and use the arrow keys to select On and then press **Enter Menu**.

12. Press **Exit** to close the box.
    Voyager will begin a run on Column V.
    Voyager will now run continuously until it has performed the preset number of runs. If you have set the instrument to run continuously it will run until it encounters a critical fault such as a lamp failure, low battery or carrier gas pressure fault.

Autostart GC on VOC Alarm

Voyager's TVOC mode can be programmed to automatically start a GC analysis when the VOC encounters an alarm condition, a feature that can be used for automated site monitoring.

You may set up Voyager to run automatically in TVOC mode. If it encounters a concentration that exceeds a preset alarm level, it will run a GC analysis according to the method that is loaded. It will then return to TVOC monitoring.

1. Calibrate the GC and the TVOC as outlined in *Calibration* starting on page 223.

   You just calibrate both the GC and the TVOC once every 8 hours of operation, though some assays may require more frequent calibration, refer to the Assay User's Notes for details.

2. Press **Enter Menu**, then DISPLAY, VOC and REPORT (or GRAPH).

3. Press **Enter Menu**, then LIBRARY, and ALRM and enter the alarm level.

4. Press **Enter Menu**, then SETUP, MODE, AUTO and VOC-GC and use the arrow keys to select On.

5. Press **Enter Menu** to confirm the selection.

6. Press **Exit** and DELAY, and enter a delay time.

   This value must be greater than 1 minute.

7. Press **Enter/Menu** to confirm the value.

8. Press RUNS and enter the number of runs to be performed.

   If you want the instrument to sample continuously enter zero, which is the default value.

9. Press **Enter/Menu** to confirm the value.

10. Press **Exit** and ON/OFF (the soft key), then use the arrow keys to select On.

11. Press **Enter Menu** to confirm the selection.

12. Press **Exit** to close the box.

    Voyager will begin a run on Column V.

    Voyager will complete an analysis for each alarm condition encountered by the TVOC. If the GC method consists of three runs, the GC will perform three runs before returning to TVOC operation.

Logged Data

The datalogger is always on, so that all analyses are logged. The datalogger will hold approximately 40 GC log entries, which is sufficient for an 8 hour day with one run every 10 minutes. Every GC analysis recorded in the datalogger will include a complete peak report and chromatogram.

To view the GC log the instrument must be in the GC mode. To view the TVOC log the instrument must be in the TVOC mode. Since TVOC logs occupy less memory, up to 255 TVOC entries can be stored. Both GC and TVOC logs share the same memory resource. Each successful calibration also occupies a full GC memory space.

The status line shows the log entry number and sample date and time. The column and the run number will be shown on a second status line. The two lines of information will alternate.

Review Logged Data

1. Press **Enter Menu**, DISPLAY.
2. Select GC to review GC analyses

   OR

   VOC to review TVOC analyses.
3. Select the display you require.
   If you are in GC mode, select PEAK, CMPD, or GRAPH.
   If you are in TVOC mode, select REPORT or GRAPH.
4. Press **Enter Menu** to close the menu.

5. Press **Enter Menu** to re-open the menu and press LOG.

   The display will show the most recent Log entry. If the last analysis is complete, it will be the same as the real time display. The display remains the same as the selected display. If you are in peak display, the logged data will be shown in peak display.

6. Press VIEW to review the datalogger entries.

7. Press NEXT or PREV to move through the entries.

   The status line shows the log entry number and the date and time the sample was taken. Alternately, the column and the run number will be shown on the status line. The two lines of information will alternate.

NOTE: *If you are reviewing GC data, you can change the display by pressing DISPLAY and selecting the desired display option. If you are reviewing TVOC data then you can choose to display REPORT or GRAPH format.*

8. Press **Exit** to return to the real time display.

Deleting Datalogger Entries

When the datalogger becomes full you must delete the contents. You can delete selected datalogger entries using the delete option.

NOTE: *You can connect Voyager to a PC and use the SiteChart software to store the logged data, as detailed on page 140. It is strongly recommend that SiteChart is used to download data from Voyager. The datalogger entries are saved in a folder created on your PC and then deleted from the datalogger.*

Deleting a single entry

1. Press **Enter Menu**, then LOG and VIEW.

2. Press NEXT or PREV to move through the entries and select the log entry to be deleted.

   Press **Exit** to go back one level on the menu tree.

3. Press DELETE, CURRENT, CURRENT.
   The selected entry will be removed from the datalogger.

Deleting a range of entries

1. Press **Enter Menu**, then LOG and VIEW.
2. Press DELETE and RANGE.
3. Use the arrow keys to enter the number of the start log entry and press **Enter Menu**.
4. Use the arrow keys to enter the number of the end log entry and press **Enter Menu**.
   The selected range will be removed from the datalogger.
   The remaining entries will be numbered sequentially.

Removing all the entries in the datalogger

1. Press **Enter Menu**, then LOG, DELETE and ALL.
   You will be prompted to confirm that you want to delete all entries.
2. Press YES.
   The data is deleted.

Using the ECD

WARNING

To ensure that removable radioactive contamination on the external parts of the ECD remains at a safe level, the U.S. Nuclear Regulatory Commission requires that the ECD be wipe tested at least once every 6 months. A record of the results must be maintained for NRC inspection for a period of three subsequent years.

In Canada, the ECD must be wipe tested at least once every twelve months and a record of the results must be maintained for AECB inspection for a period of three years.

WARNING

Do not open Voyager or remove the ECD. If the ECD must be removed from the instrument contact PerkinElmer Photovac Service.

Operation of ECD is fully automated. This includes setup and operation of the ECD. The only setup required is to vent the detector and ensure the detector has been selected for operation. Switching the column effluent to the ECD from the PID is done with the SETUP key. You do not need to open the instrument in order to setup the ECD.

Your method will determine the detectors that are in use. Your method may require the PID and the ECD, the ECD only or the PID only. If the ECD is used as part of the assay, Voyager will set the temperature and adjust the valve settings to direct the column effluent to the correct detector. This will be done when the assay is downloaded to the instrument.

If you need to develop your own method, you can select the ECD, PID or both, as described in *Selecting Columns and Detectors* on page 200.

NOTE: *You must use nitrogen carrier gas when you are using the ECD. If the internal cylinder was used for air, fill it with nitrogen and purge it. Do this twice to ensure there is no air in the cylinder. Use Ultra High Purity grade nitrogen. Use the refill adapter (MX380303) to fill the internal cylinder.*

Setting up the ECD

1. Use flexible tubing fitted with luer adapters to vent the effluent from the ECD (port 2).

   Vent the detector well away from the instrument and all users. If you are using the GC indoors, you may want to vent the detector outside.

NOTE: *Venting the ECD outlet does not affect the performance as long as the tubing does not provide any restriction. Ensure the tubing is not kinked or stressed.*

2. Change the view from the PID to the ECD by pressing **Enter Menu**, then DISPLAY, GC, and DET.

3. When prompted to change views to the ECD, press **Enter Menu**.

4. When you first select the ECD for operation, monitor the offset level as displayed on the status screen and wait until it has stabilized before attempting to use the instrument.

   An instrument that is cleaning out will show an unstable and dropping baseline. Typical offset is in the range 200-800 mV and anything over 800 mV indicates contamination.

5. Once the baseline is stable, calibrate the instrument as outlined in *Calibration* starting on page 223.

High Accuracy Operation

When you are analyzing critical samples, you must allow Voyager to stabilize for a few hours before performing any runs. You must also calibrate the instrument immediately before analyzing the critical samples.

Your calibration gas must contain all of the library compounds. The concentration of the calibration compounds should be close to the concentration of the target compounds.

You should also run an analysis of the calibration gas before and after running the critical sample to ensure that the Voyager was performing correctly during the analysis. If you calibrated directly from the tank of calibration gas, run an analysis with Voyager connected directly to the tank. If you used a gas bag for calibration, empty and refill the gas bag and then run an analysis using the gas bag as a sample.

SiteChart Software 4

Introduction

To perform any data analysis or to print chromatograms you must connect Voyager to a PC running SiteChart software. The SiteChart software is designed to run under Microsoft Windows. SiteChart enables you to:

- Load assays
- Control Voyager
- Download assays to Voyager
- Retrieve log analysis information from Voyager
- Review log files
- Compare a compound over several different analyses
- Create a new assay
- Add or remove compounds from the assay to create a new library
- Modify chromatographic parameters in order to develop your own assay

Installation

SiteChart software is installed on a PC that you can connect to Voyager directly via the serial port of a PC using the Communication Cable Kit (MX380304).

PC Requirements

The PC must meet the following hardware and software requirements to run the SiteChart software:

- Pentium® based personal computer
- 8 MB of RAM for Windows 95, 16 megabytes (MB) of RAM, minimum, for Windows NT (32 MB is recommended for Windows NT)
- 4 Megabytes of free hard disk space
- Color, 600 x 800 display, adapter card and monitor supported by Windows
- A Windows compatible printer is required in order to obtain printed reports
- A mouse or another pointing device supported by Windows
- A 3.5" disk drive.

Connecting a Remote Computer

For added flexibility you can control Voyager through a remote computer. In this configuration you will connect the computer at your location to a modem. You dial out to a second modem connected to Voyager. This option will be useful if you need to call into Voyager from home or from a separate location to view results. Also, if an alarm or fault condition is encountered SiteChart can dial out and send an alarm or fault message.

To do this, in addition to the system described above you will also need an external modem for Voyager and a modem for the remote computer, both 9600 baud or faster.

General Installation Information

To install SiteChart you must have a 3.5" disk drive and 5 megabytes of free hard disk space. The Setup utility detects minimum system requirements and warns you if your system does not meet the requirements.

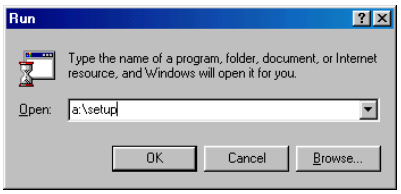
There are a few things you can do before you begin to ensure installation goes smoothly.

- Turn off any virus protection software you are using, as it may interfere with the Setup utility.
- Exit any Windows programs you are running, this frees up memory for installation and prevents possible conflicts between Setup and other programs.

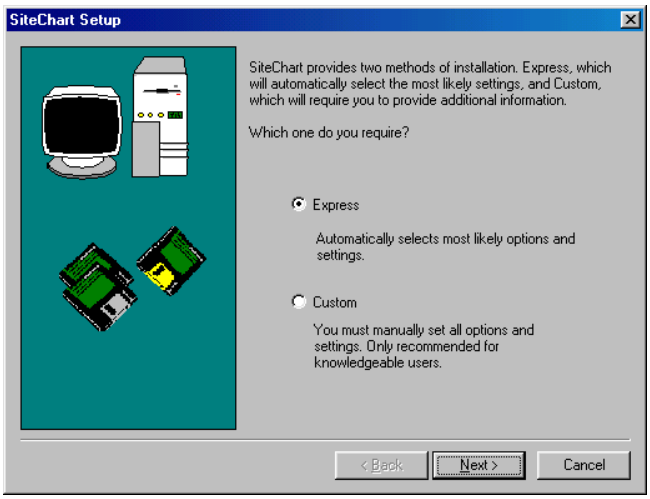
Installing the SiteChart software

NOTE: *The following instructions assume you are installing from drive A onto drive C. Run the Setup program from the 3.5" drive and install the SiteChart software onto the hard drive. The default directory is c:\Program Files\SiteChart\Program, if you are installing to or from a different drive, substitute the appropriate drive name in the following procedure.*

1. Start Windows.
2. Insert SiteChart Disk #1 into the floppy drive.
3. Select **Run** from the Start menu.
   The Run dialog is displayed.
4. Type **a:\setup**, as shown below, and click **OK**.



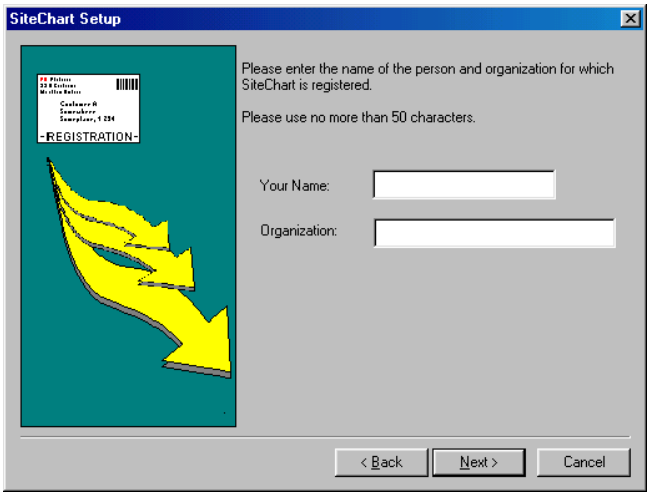
   The installation choices are displayed.


SiteChart Setup
SiteChart provides two methods of installation. Express, which will automatically select the most likely settings, and Custom, which will require you to provide additional information.
Which one do you require?
Express
Automatically selects most likely options and settings.
Custom
You must manually set all options and settings. Only recommended for knowledgeable users.
< Back
Next >
Cancel

5. Select the installation option you require and click **Next**.

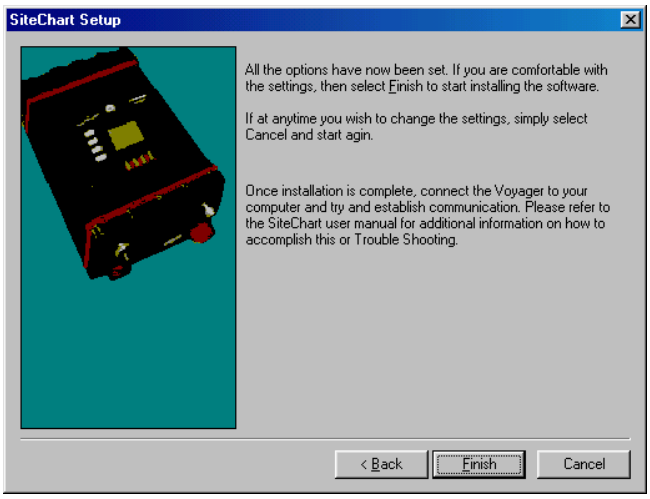
   If you select **Express**, the SiteChart software wil be installed to the default directory, c:\Program Files\SiteChart\Program.

   You are now required to enter the registered user.


SiteChart Setup
-REGISTRATION-
Please enter the name of the person and organization for which SiteChart is registered.
Please use no more than 50 characters.
Your Name:
Organization:
< Back
Next >
Cancel

6. Enter **Your Name** and **Organization** and click **Next**.

   A confirmation dialog is displayed.


SiteChart Setup
All the options have now been set. If you are comfortable with the settings, then select Finish to start installing the software.
If at anytime you wish to change the settings, simply select Cancel and start agin.
Once installation is complete, connect the Voyager to your computer and try and establish communication. Please refer to the SiteChart user manual for additional information on how to accomplish this or Trouble Shooting.
< Back
Finish
Cancel

7. Click **Finish**.

   The installation begins.

   A message will be displayed when the second disk is required.

8. Remove the first disk, insert SiteChart Disk #2 and click **OK**.

   The installation continues.

   Upon completion of installation, the setup utility will place icon in a new group called PE Photovac SiteChart.

NOTE: *After installation is complete do not delete any Voyager files from the c:\Program Files\SiteChart\Program directory. Do not change the locations or names of these files or their directories. The applications will be unable to find the necessary files and they will not work properly if at all.*

Upgrading from Previous Versions

If you have a previous version of SiteChart installed, you do not need to remove it from your system before installing the most recent version, simply follow the installation instructions above. The setup utility will overwrite the previous version during installation as this version of SiteChart is completely compatible with the previous version and you do not need to keep two versions on your system.

Installing your Assay Disk

Your Voyager is supplied with a disk with the Assay you have specified, customized for your Voyager. The data on this disk must be transferred to the PC so that it can be loaded into your Voyager.

1. Create a new directory on the PC called **c:\Program Files\SiteChart\Data\assayX**, where X is the number of the assay.

   Create a new directory for each assay you need to load onto the PC.

   If you have more than one instrument, create a directory for each instrument as assay disks are specific to the instrument with the matching serial number.

2. Copy all of the files from the Assay disk(s) to the correct directory using Windows Explorer.

Connecting the PC to Voyager

Personal Computer

WARNING

Do not connect a PC to Voyager in hazardous locations.

Use the supplied communication cable (Part No. MX380304) to connect the computer to Voyager. The communication cable is a 25 to 9 pin cable.

1. Turn Voyager off.

   You must turn the instrument off before connecting or disconnecting the communication cable.

2. Connect the 9-pin connector end of the communication cable (MX380304) to the RS-232 port on Voyager.

   Connect the 25-pin connector end to an unused serial port on your computer. The serial port may be identified as COM 1 or COM 2. You will need one of the two adapters, supplied with the communication cable. If you have connected the communication cable directly to the computer you are most likely connected to a parallel port.

NOTE: *Voyager cannot communicate with a parallel port.*

Communicating with Multiple Instruments

NOTE: *If you are using multiple instruments with a single copy of SiteChart, ensure you end communication with one instrument before connecting another instrument to the computer.*

1. When the first Voyager has downloaded all its information to the computer, turn it off and disconnect the communication cable from the instrument.

   SiteChart will display a message indicating that it has lost connection with the instrument. Do not connect another instrument to the computer until SiteChart displays this message.

2. Ensure the second Voyager is off and connect the communication cable to the RS-232 port.

   SiteChart will establish communication with the second instrument and create a corresponding data directory.

Connecting a Printer to the Computer

Windows controls all printing from the computer. Although you issue the print commands from SiteChart, Windows performs the actual printing. The choice of printers is only limited to those printers supported by Windows.

Ensure that the printer you are using is compatible with Microsoft Windows. Refer to the *Microsoft Windows Hardware Compatibility List* for information on which printers are supported by Windows.

The printer can be locally connected to the computer's parallel port or attached to your computer network. The printer must be setup on the correct port and the printer driver installed. This is done during installation of Windows or through the Windows Control Panel. Refer to the documentation supplied with Windows for more information.

Loading an Assay into Voyager

Now you can download the assay supplied with your Voyager into the instrument.

1. Start the SiteChart software.
2. On the Assay tab, select **Open** from the File menu and open the assay method file (.app), from the c:\Program Files\SiteChart\Data\assayX directory set up previously (see *Installing your Assay Disk* on page 106).
3. Make sure Voyager is connected to the PC as described in *Connecting the PC to Voyager* on page 107.
4. Click **Send to Voyager**.
5. Once the file has been downloaded, allow at least 20 minutes for Voyager to reach the new assay set points.
6. Calibrate Voyager as described in *Calibration* starting on page 223.
   You must calibrate Voyager so that compound concentrations will be accurately reported.

Switching Assays

If you have ordered more than one assay for your instrument, you should copy all of the assay information from the disks to your PC, creating a separate directory for each assay.

To switch between assays:

1. From the Assay tab of the SiteChart software, select **Open** from the File menu and open the required assay.
2. Click **Send to Voyager**.

3. Once the file has been downloaded, allow at least 20 minutes for Voyager to reach the new assay set points and then calibrate Voyager.

   If you have installed an assay that requires different carrier gas, you must purge the carrier gas reservoir. Once you have filled the reservoir with the new carrier gas, you must allow the instrument to purge for a few hours, preferably overnight. This will flush the analytical engine with the new carrier gas.

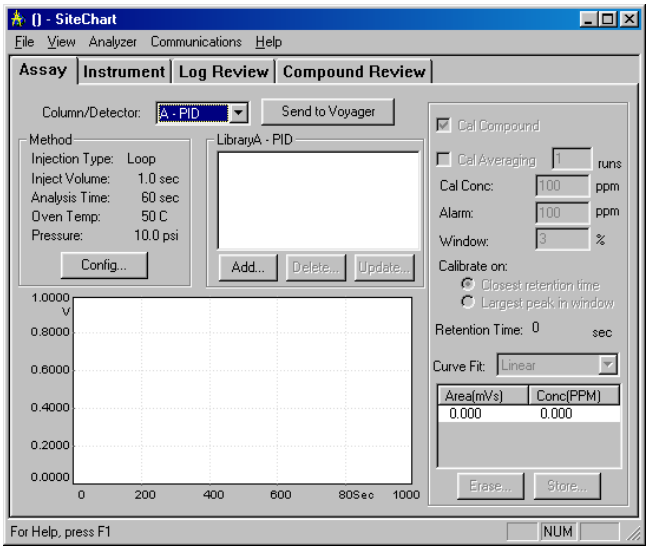
NOTE: *The Assay 1 method is specific to an Assay 1 instrument. You cannot install Assays 2 through 7 on an instrument configured for Assay 1.*

Overview

Starting SiteChart

➢ From the Windows Start menu, select **Programs**, then **PE Photovac SiteChart** and click **SiteChart**.

The default window is displayed.



The Default Window

The default window consists of a title bar, the menu bar and a status bar.

The title bar of the window contains the active file. The menu bar contains a list of menus. You open the menus and select commands to control the operation of SiteChart.

- The File Menu controls opening, saving, printing and transferring of analysis results, assays and log files.

- The View Menu allows you to select the type of data to be displayed.

- The Analyzer Menu controls Voyager.
- The Communications Menu controls communication between Voyager and the computer and also between local and remote computers.
- The Help Menu provides information about using SiteChart.

The tabs below the title bar provide a quick interface from which you can control operation of SiteChart or Voyager, and review logged data.

The menu commands will act for the active tab. For example, if the Instrument tab is active, then the **Print** command on the File menu will print an analysis report of the chromatogram that is displayed, but if the Assay tab is open then an assay report will be printed.

Sizing the Application

You can size SiteChart to fill your entire desktop or a portion of the desktop to suit your application.

➢ To maximize the application screen or a tab, click on the maximize button.

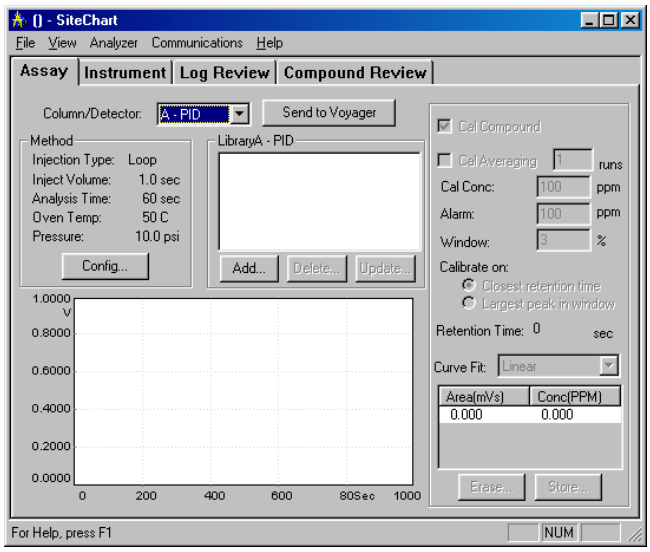
➢ To reduce the application to fill a portion of your screen, click on the restore button.

You can then size the window to the desired dimensions by clicking on the outer edge of the window and dragging the edge out to the desired size.

The application window will be sized to fit the selected dimensions.

➢ To reduce the application to an icon, click on the minimize button.

The Assay Tab



The information in the Assay tab is used to define the chromatographic method for your application. One assay has been provided with your instrument. Use the assay to familiarize yourself with the operation of both Voyager and SiteChart. When you are comfortable using Voyager and SiteChart, you may want to customize the method to better suit your application.

Assay notes have been supplied to provide specific information related to your assay. Refer to the assay notes before making any modifications to the method.

Installing the Standard Method

You need to download the method to Voyager as part of the initial instrument set up procedure.

Follow the instructions below:

1. Make a copy of the assay disk, and store the original.

2. Create a new directory for your assay disk.
   If you have more than one instrument, create a directory for each instrument. Assay disks are specific to the instrument with the matching serial number.

3. Copy the contents of the assay disk into this directory.
   Each assay you have ordered will be supplied on one 3.5" disk. Refer to the assay notes for details of the files on the disk.

4. Connect Voyager to a serial port on the computer.

5. Turn on Voyager and allow it to warm up.

6. Start SiteChart.

7. Go to the Assay tab and open the assay.
   Depending on which assay you are loading, you may be prompted, by Assay Wizard, to configure your library with respect to co-eluting compounds. See *Assay Wizard* on page 115.

8. Check the assay settings and then click on the Send to Voyager button.
   If assays created on one instrument are downloaded to a second instrument an error message will be displayed. You must update the library for the second instrument as outlined in *Updating Library Information* on page 121.
   Once the file has been downloaded, Voyager has been set up for your assay.

9. Calibrate Voyager.

NOTE: *You must calibrate Voyager so that compound concentrations will be accurately reported.*

Assay Wizard

Assay Wizard is displayed when opening an assay that contains multiple peaks with similar retention times. Assay Wizard will allow you to select one compound, in the co-elution, for your application. Assay Wizard will only appear if a co-elution has been identified in your assay.

1. Select the Assay tab and open your assay (***Ctrl* + *O***).
   If the assay contains co-elutions, Assay Wizard opens.
   Step 1 of the wizard provides information about the assay.

2. Click **Continue** to go to the next step.
   If you click **Cancel**, Assay Wizard will not modify your library and your compounds of interest may be misidentified or concentrations may be inaccurate.
   Assay Wizard now scans the library, looking for compounds with similar retention times. When it finds something it prompts you to pick one of the compounds.

3. Select the required compound.
   If neither of the displayed compounds is required for your application, then click **None**.

4. Click **Continue** to move to the next co-elution.

NOTE: *As you move through Assay Wizard, remember the compounds that you do not select are possible interferences.*

When Assay Wizard finishes, it will update all the column libraries accordingly and will remove the unwanted compounds from the libraries. If there is a chance that any of these compounds may be present at any time, then you must abort Assay Wizard and leave the compounds in the library.

Compound names are limited to 15 characters in order to fit Voyager's display. Some names have been abbreviated in order to meet the 15-character limit. Refer to the assay notes for a list of abbreviations.

Column/Detector Selection

The **Column/Detector** drop-down list box allows you to select the column/detector combination for reviewing and editing the assay. Your method may use one, two or all three columns to complete an analysis. If your method consists of runs on two or three columns, you must configure one column at a time. Configure all of the columns required for your application before you send the assay to Voyager.

The library for the selected column will be displayed in the Library block and the method specific to the column/detector combination will be displayed in the method block.

To select a column/detector combination:

1. Select the Assay tab.
   Ensure your assay is loaded.

2. Click on the arrow of the Column/Detector drop-down list box.

3. Select the desired column/detector combination.

Method

The standard method is listed in the Method Box. The injection method, the injection volume, the oven temperature, pressure and the analysis time are listed in the method box. These are all set when you open an assay.

NOTE: *Do not change any of the chromatographic settings, as the reference library will be lost.*

Open the Config box to change the method settings. Refer to the *Method Development* section for details of method development, or assay specific details are provided in the assay notes.

Reference Chromatogram

The reference chromatogram on the Assay tab may be used to modify the library information. Only one run can be displayed. This chromatogram does not change when you select a different column/detector combination. It may not be the chromatogram associated with the currently selected column/detector combination or the library.

NOTE: *Before making any changes to the assay, ensure that the displayed chromatogram was run on the same instrument using the currently selected column.*

When you save the assay, the chromatogram is also saved. When you load a new assay, SiteChart will try and load the analysis file as well. If it cannot be located, then a message is displayed and the remaining assay information is loaded.

View Pop-up Menu

A pop-up menu, with the View menu options, is displayed by moving the mouse into the graph area and clicking the right mouse button (right-clicking).
The Pop-up menu has the following functions:

- Turn the **Grid** on or off.
  The grid makes it easier to estimate retention times and peak heights from the chromatogram.

- **Smooth** the chromatogram by the required number of **Points** so that low concentration peaks can be more easily integrated.
  After the chromatogram has been smoothed, you can re-integrate it.

- You can change the **Integration Method** and **Reintegrate** the chromatogram.
  This is useful if you need to store peaks that are not well integrated.

- Change the **Font size** of the text on the chromatogram.
  You can set the font to **Small**, **Medium**, **Large** or **Automatic**. **Automatic** adjusts the font size to fit the current view options.

- **Peak Labels** option selects the peak labels that are displayed on the graph.

  None displays no peak labels.
  Numbers will number each integrated peak.
  Labels will display the peak name if the peak can be identified**.**
  Numbers and Names displays a number and the peak name.

- Turn the **Status Block** on or off.

  The status block displays the signal level and the slope of the signal at a time defined by the position of the cross-hair. The cross hair does not need to be directly on the signal.

- **Previous Zoom**, **Auto Range** and **Normalize** all allow you to view the chromatogram in different ways.

- **What's This** allows you to get on-line help for the reference chromatogram.

Loading a New Reference Chromatogram

To load a new reference chromatogram:

1. Select the Assay tab.

2. From the File menu select **Open** and open the .PID or .ECD file containing the chromatogram that you want to display.

   When the file is loaded, the chromatogram will be displayed in the graph block. This file may be independent of the selected column/detector combination and the library.

NOTE: *Before making any changes to the assay, ensure that the displayed chromatogram was run on the same instrument using the currently selected column/detector combination.*

Peak Information Tool Tip

To obtain information about the peaks in the chromatogram:

- Move the mouse pointer over any peak in the chromatogram.
  When you move the pointer into the graph area, the pointer changes into a cross-hair.
  Leave the cross hair over the peak and an information box will pop-up. The box contains the peak name, retention time and the integrated area.

Zoom Feature

To zoom in on any area of the chromatogram:

1. Move the pointer to one corner of the zoom box.
   The zoom box will be the area that you want to zoom in on.
2. Press the left mouse button and drag the mouse to the opposite corner of the zoom box.
   When you release the left mouse button, SiteChart will enlarge the selected area to fit the chromatogram box.
3. Repeat these steps until you have obtained the desired view.

- To return to the previous zoom view, open the pop-up menu and select **Previous Zoom**.
  You can also select the Previous Zoom option from the View menu.

Window Percent

To adjust the window percent directly in the chromatogram:

1. Select the Assay tab.

2. Open the .PID or .ECD file containing the chromatogram run on the currently selected column.

   When you select a compound in the library, the compound matching the library retention time will be selected in the reference chromatogram. Three dashed, blue lines will display the current window percent around the peak.

3. To change the window percent value for the selected compound, move the crosshair onto one of the outer lines and drag the line closer or further from the peak. When you release the mouse button the window percent will be updated accordingly.

   You can also set the window percent by entering an exact value in the compound information box.

   Setting the window percent may require some practice. If the window percent is too small, the peak may drift out of the window and the compound may not be identified. If you set the window percent to high, your peak may be misidentified.

Compound Library

A compound library is supplied for each column/detector pair required for the assay. The number of libraries is determined by the assay. These libraries have been determined for the assay standard method. The libraries are always available on the assay disk so you can use the original method and the information in the library.

When you open an assay you will open a copy of the library. Once it has been opened in SiteChart, it becomes the current library. You can edit it and update it as required by your application. If you modify the current library in any way, you must save the assay.

If the method is changed, the reference libraries are no longer valid and will automatically be deleted from SiteChart. Refer to the assay notes for details of the reference library and the associated method.

Updating Library Information

If your chromatographic settings have not changed from the original assay, but library compounds are not correctly identified or not identified at all, they may have drifted out of the peak recognition window. You can update library information based on a recent chromatogram that has been run using the original assay.

To update library information:

1. Select the Assay tab.
2. Open the original assay and save it with a new name.
3. Click **Send to Voyager** to send the assay information to Voyager.
4. Select the first column/detector pair.

   If your application uses 2 or 3 columns you must repeat this procedure for each column. If you are using the ECD, you must repeat this procedure for each ECD library.
5. Remove all the unwanted compounds from the library.

   To remove a compound from the library, select it and press **Delete**.
6. Run a chromatogram on the selected column/detector pair.

   The chromatogram must contain all the compounds listed in your library. It must also be run using your original assay method.

   Allow Voyager to warm up for at least 30 minutes before running the chromatogram.
7. Re-integrate the chromatogram.

   Use the **re-integrate** command in the Analyzer menu or right-click on the chromatogram and select **re-integrate** from the pop-up menu. Compounds matching library information will be identified.
8. Click on the first compound in the library.

9. Review the data in the library information box.

   Compounds present in the calibration gas must be selected for calibration. Compounds that are not present in the calibration gas must be removed.

NOTE: *All compounds contained in the library must be contained in the calibration gas. If this is not the case, contact PerkinElmer Photovac Technical Support.*

10. Ensure you have entered the correct calibration concentration.

    This is the concentration of the compound in your calibration gas.

    Blue dashed lines will be displayed where SiteChart is expecting to find the compound.

11. If the compound peak is the only peak within the retention time window, click **Update** or double-click on the peak to open the Update dialog box. If the information in the box is not correct, enter the correct data and click **OK**.

    OR

    If the compound peak is not within the retention time window or if there are other peaks in the retention time window, drag the center, blue, dashed line to the desired peak. The retention time will be updated automatically.

12. Repeat this procedure for each library compound.

13. Re-integrate the chromatogram.

    Select **re-integrate** from the Analyzer menu or right-click on the chromatogram and select **re-integrate** from the pop-up menu.

    Each compound should be correctly identified.

14. If you are using another column for your application, repeat this procedure for the next column.

15. Save the assay and then send it to Voyager.

16. Select the Instrument Tab and run an analysis on each column.

17. Ensure all compounds are correctly identified and then use these analyses to calibrate Voyager.

Interference Compounds

Compounds can be added to the library for identification purposes only. Using this feature will allow compounds to be identified in a peak report but no concentration data will be calculated. Interference compounds, included in some assays, are provided in this way. Compounds listed in the library without response data still need to be calibrated for retention time drift.

To assign interference compounds:

1. Store the compounds as outlined in *Adding Compounds to the Library* on page 175.

2. Select the compound in the library.

3. Select the point in the area/concentration table and click **Erase**.

   The response data for the compound will be removed. The (0, 0) point and the retention time information remain in the library.

4. Save the assay.

Compound Library Information

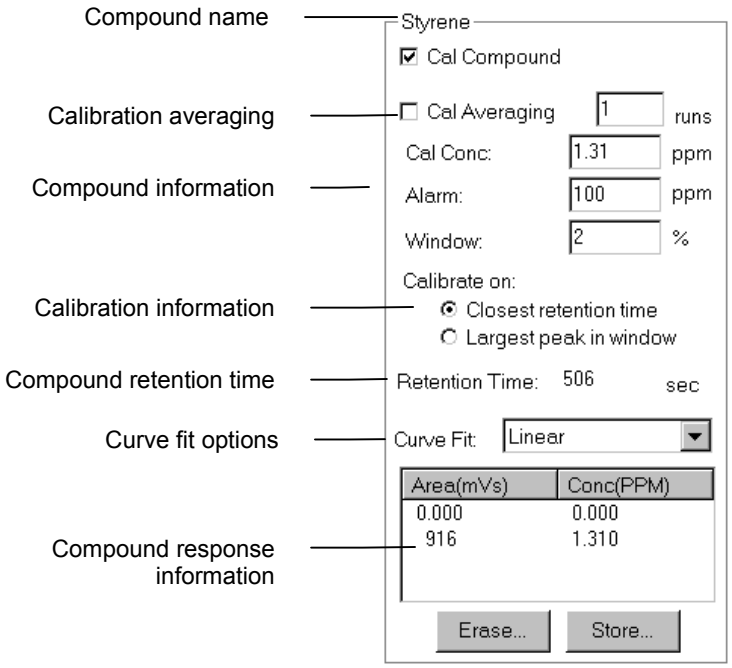


Figure 5 Compound Library Information Box

The library information for the selected compound is displayed in an information box on the right side of the Assay tab. The box contains all the calibration information for the peak currently selected in the library. The library information is used by SiteChart to identify and quantify integrated peaks.

Details of each parameter are not provided in this section. A brief description of each parameter will be covered in the method development section where you will use all these features to add compounds to the library.

Enabling Calibration Compounds

The first check box allows you to select the compound for calibration. If the compound is present in the library you must calibrate on it. If it is not required as part of your application remove it from the library.

During calibration, Voyager looks for all the calibration compounds and updates its library information based on the retention time and response for each calibration compound.

Calibration Averaging

The second check box enables calibration averaging. If you enable this option, you must also enter the number of runs you want averaged. It provides a method to ensure reliable calibration for potentially unstable compounds. You can also use calibration averaging when you are calibrating by syringe injection.

Calibration averaging allows you to update the response of a library compound based on the average of one or more runs. If the number of runs is set to 1, the response of a single calibration run is copied directly into the library and there is no averaging. If the number of runs was changed to three, the library will take the average of the next three calibration runs and update the response factor. As you perform more calibrations the three most recent calibrations will be used to update the library response.

There is independent control of calibration averaging for each compound. This allows you to have higher averaging factors for those compounds that exhibit less repeatability.

NOTE: *Do not enable calibration averaging for compounds not contained in the calibration gas.*

If you are using calibration averaging to update compound information that may be unstable, you may want to calibrate more frequently to ensure that your library response is reliable.

Other Features

- Enter the concentration of the compound in the calibration gas.

  This concentration should be close to the concentration to be detected.

- Enter an alarm level.

  If an alarm is exceeded an audible alarm may sound and an alarm acknowledge box will be displayed. The audio options are selected on Voyager itself, see *Audio Options* on page 77.

- Enter the window percent.

  The window percent is the deviation in retention time for which Voyager will compensate. For example, if the window is set at 10%, a compound with a retention time of 100 seconds will still be identified if it elutes between 90 and 110 seconds. Most compounds have a 3 – 5% window.

- Select how you want the peak identified: as the largest peak in the window or as the closest retention time in the library.

  If there are interference compounds, that appear at the same retention time, but are not as responsive to the PID or are present in very low concentrations, then select the largest peak in the window.

  If the interference compound is close in detector response, but has a different retention time, then select closest retention time.

Calibration Curve

Select the desired curve fit option. You must create the calibration curve by storing the compound at multiple concentrations throughout the range of your application. You can store up to 5 concentration points.

If it is not possible to store the compound at 5 concentrations, store the compound at two concentrations within the range of your application to ensure the best results. The concentration and the corresponding area are shown for all concentration points that you have stored. See *Multiple Point Calibration Curve* on page 178 for details of storing a compound at more than one concentration.

Once you have stored multiple points you can select the best curve to fit the points.

If one concentration point is stored, SiteChart draws a line from this (0, 0) to the single point and uses the line as the calibration curve. If the compound is stored at a second, higher concentration, sample concentrations are calculated using the first sensitivity when the concentration is below the lower concentration. For concentrations above the lower value, SiteChart uses a sensitivity value calculated from the slope of the line connecting the two concentration response points.

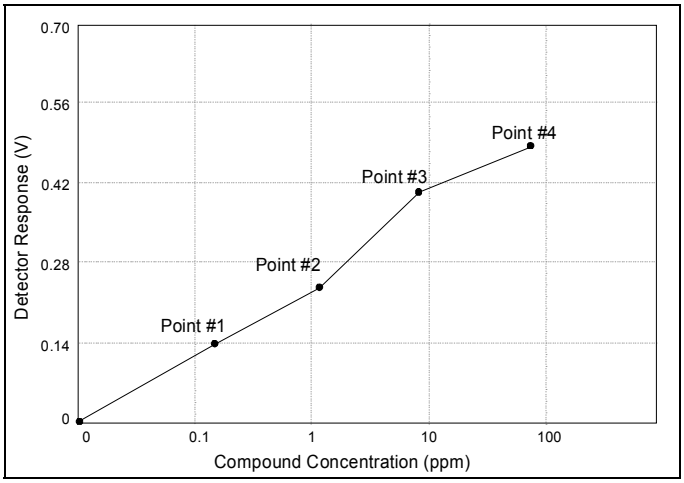


Figure 6 Linear Calibration Curve

If a third, higher concentration is stored, then the concentrations above the second value are measured using a sensitivity value calculated from the slope of the line connecting the second and third concentration response points. You can store up to five concentration points.

A quadratic calibration curve fits a quadratic function to the points you have stored. In order to use the quadratic calibration curve, you must store at least 2 or more points. The curve will always start at (0, 0) and go through at least 2 points you have stored and (0,0).

In order to obtain the most accurate results you should store a point that is at the top end of the desired concentration range. If you are interested in the range 10 to 100 ppm, store a point at 100 ppm. Data past this point will be extrapolated based on a tangent through the last stored point.

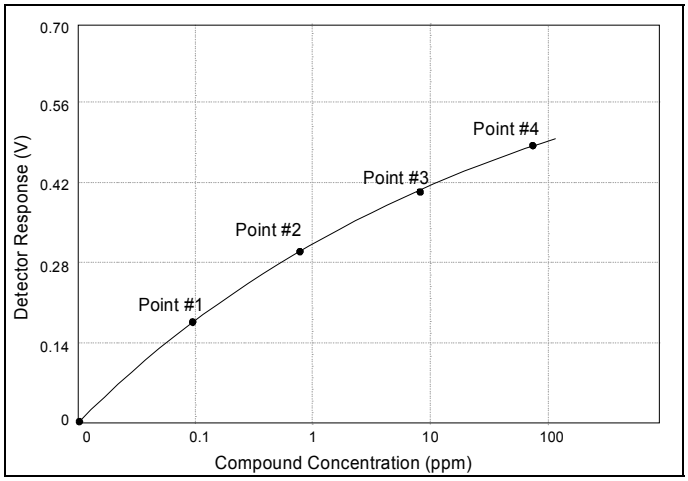
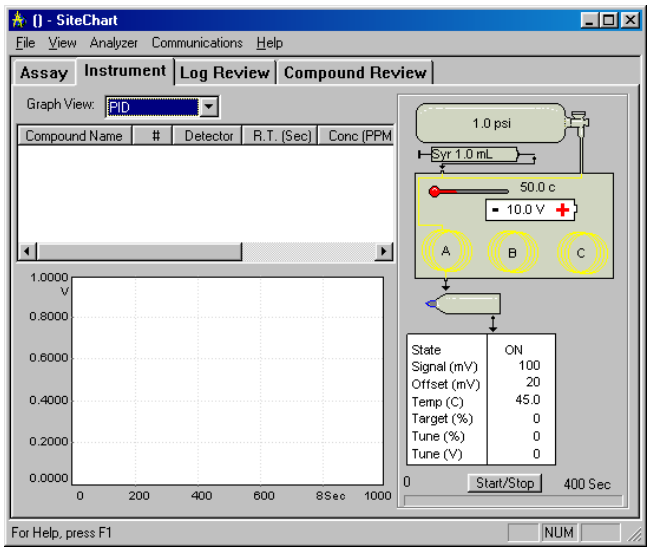


Figure 7 Quadratic Calibration Curve

The Instrument Tab



The Instrument tab is used to control the instrument. Only one instrument may be connected at a time. You can run multiple copies of SiteChart to control multiple instruments. See *Connecting Multiple Instruments* on page 164. You must have a serial port for each instrument. Alternatively, you can connect one instrument at a time to the computer. See *Communicating with Multiple Instruments* on page 108. The Instrument tab displays a chromatogram, a peak report and an instrument status bar. When you are controlling the instrument from SiteChart, use the Instrument tab to monitor the progress of analyses and the status of the instrument.

Peak Report

The peak report displays a listing of the detected peaks. Peaks that match a library retention time are identified and those that do not are listed as unknown.
The following information is provided for each peak:

Parameter	Description
Compound	The compound name as listed in the library. A red X before the compound name indicates the detected concentration has exceeded the preset alarm level.
#	The peak number in the current chromatogram.
Det	The detector used. This will be a PID or an ECD.
R.T. (sec)	The peak retention time.
Conc. (ppm)	The detected concentration as determined from the library response value. Compounds with no response data such as interference compounds will always be reported as 0.0 ppm.
Area (mVS)	The integrated area. This is determined from the integration method.
Height (mV)	The peak height.
Status	The status of the peaks. Ratio-metric calibration may lead to an invalid calibration and is intended for specialized applications only. Please contact PerkinElmer Photovac Technical Support for more details.

Each one of these fields can be sized.

To size individual fields:

1. Move the mouse to the edge of the field.
   The pointer will change into a double-headed arrow.

2. Press the left mouse button and drag the arrow to set the field to the desired size.

Chromatogram

The chromatogram is displayed in the graph box. Select the signal to be viewed from the Graph View drop-down box. You can select TVOC, PID, ECD or PID and ECD. If you select PID and ECD the graph will be split and you can view the signal from each detector.

A pop-up menu, with the View menu options, is displayed by moving the mouse into the graph area and clicking the right mouse button (right-clicking). The view options are described in *Reference Chromatogram* on page 117.

Peak Information

To obtain information about the peaks in the chromatogram:

1. Move the mouse pointer over any peak in the chromatogram.
   When you move the pointer into the graph area, the pointer changes into a crosshair.

2. If you leave the cross hair over the peak an information box will pop-up.
   The box contains the peak name, retention time and the integrated area.

Zoom Feature

To zoom in on any part of the chromatogram:

1. Move the pointer to one corner of the zoom box.
   The zoom box will be the area that you want to zoom in on.

2. Press the left mouse button and drag the mouse to the opposite end of the zoom box. When you release the left mouse button, SiteChart will enlarge the selected area to fit the graph block.

3. Repeat these steps until you have obtained the desired view.

➢ To return to the previous zoom view, open the pop-up menu and select **Previous Zoom**.
   You can also select the Previous Zoom option from the View menu.

Instrument Status

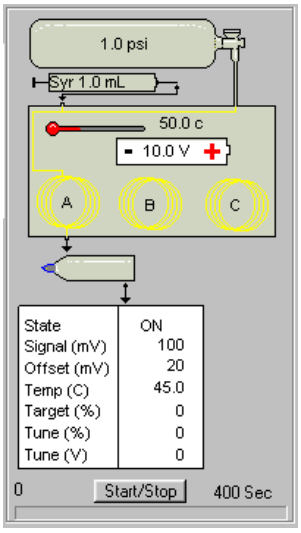


Figure 8 Example instrument status

When the instrument is connected to the computer, the information in the instrument status box is continuously updated to ensure an accurate status display.

- The displayed pressure is the column head pressure.
  This value is set by the assay that is currently loaded.
- The syringe graphic represents the injection volume.
  This is only used if loop injection is enabled. If you are performing syringe injection, you will determine the injection volume.
- The displayed temperature is the column temperature and is set by the assay.
- The battery level shows the current charge of the internal battery.
  When Voyager is connected to the AC adapter the charge should be 9.0 volts.
- The column in use will be in line with the sample loop.

- The lamp indicates the PID is in use.

  If an ECD is installed it will be displayed beside the lamp.

  Double-click on the lamp or the ECD to open a pop-up menu. You can also click on the right mouse button to open the same pop-up menu. You can turn the PID or the ECD on or off from this pop-up menu. Turn the detector off if you are not running chromatograms.

NOTE: *Turning the detector off does not turn the instrument off.*

- The PID parameters are listed in the table below the lamp.

Parameter	Description
State	The state of the detector, You can turn the lamp on or off.
Signal (mV)	The current detector signal level.
Offset (mV)	The voltage applied to keep the baseline at 10% of fullscale. The applied offset is an indication of column contamination. If the offset is greater than 800 mV the column should be allowed to flush until the offset stabilizes at a value between 200 and 800 mV.
Temp. (°C)	The operating temperature of the photoionization detector.
Target (%)	The intensity to which Voyager attempts to tune its UV lamp.
Tune (%)	The percentage of the intensity (of a reference lamp) to which the Voyager tries to tune the UV lamp.
Tune (V)	The tuning voltage supplied to the lamp control circuitry.

- If the ECD is selected for operation, parameters specific to the ECD will be displayed in a second column.

Parameter	Description
ECD Signal	The current signal from the electron capture detector.
ECD Offset	The voltage applied to keep the baseline at 10% of fullscale. The applied offset is an indication of column contamination. If the offset is greater than 800 mV the column should be allowed to flush until the offset stabilizes between 200 and 800 mV.
ECD Temp.	The operating temperature of the electron capture detector. The temperature can be set independently of the column and PID. See *ECD Temperature* on page 211.

Start/Stop Button

Selecting a Column

When you start a single run, SiteChart will begin the run on the column you selected through the Analyzer menu or the Column Selection Pop-up Menu. Your assay may require you to perform two or three runs in order to complete an analysis. One run is performed on each column. If this is the case, then you must enable all the required columns on Voyager. Voyager automatically cycles through the enabled columns each time you press the local **Start/Stop** button. 2

SiteChart overrides this process and starts a run on the selected column only. If you want to cycle through the columns that are required to complete an analysis, you have two options. If you are manually performing runs, select the required column and then press the Start/Stop button. If you are using this method, you can perform loop or syringe injections.

Alternatively, you can use the auto cycling features. When you start auto cycling, Voyager will begin a run on the next column to be analyzed. The next analysis will be run on the next enabled column. The instrument determines column selection. If you are using auto cycling, you must use loop injections. See *Auto Cycling Operation* on page 159.

NOTE: *Columns must be enabled on Voyager.*

Starting a Run

To start a run:

1. Ensure Voyager is set up correctly.

   Carrier gas must be supplied to the instrument. Voyager must be displaying a Ready status.

2. Select the Assay tab and ensure the correct assay is loaded.

3. Ensure Voyager is on and ready for operation and then send the information to Voyager by clicking **Send to Voyager**.

4. Select the Instrument tab and select the column on which to perform a run.

   Open the Analyzer menu and select the column or right-click on the column graphic in the instrument status box to open a column selection pop-up menu. Selecting **Column V** will start a TVOC run.

5. Connect a sample to the sample inlet port or allow Voyager to draw a sample of room air. If you are performing a syringe injection prepare the syringe sample.

6. Press **Start** to begin the run.

   Voyager will begin a run according to the method for the selected column.

   A timer at the bottom of the instrument status box shows you the analysis time and progress of the run.

   The chromatogram will develop in the graph box. As peaks are integrated they will be displayed in the peak report.

7. When the run is complete, SiteChart will save the run to a directory it has created for the instrument.

Stopping a Run

Once the run has been started the button changes to a stop button. To stop the analysis before it is complete, press **Stop**. If you stopped the analysis after the sample was injected onto the column you must wait for the duration of the analysis time. The column will be flushed to remove any compounds that entered the column.

When you stop an analysis, Voyager will flush the column for the duration of the analysis time before beginning another analysis on the same column.

Saving a Run

All runs are saved automatically when they are received from the instrument. Voyager creates the file name as described in *File Name Format* on page 142. To save the file with a new name, use the **Save As** command. Use **Save** when you have edited a file and need to update it.

To update an existing file:

1. Select the Instrument tab.

2. Open the File menu and select **Save** (***Alt***, ***F***, ***S)***.
   The displayed file will be saved with the current file name.

To save a file with a new name or to save an existing file to a new location:

1. Select the Instrument tab.

2. Open the File menu and select **Save As** (***Alt***, ***F***, ***A***).

   SiteChart will save the file as a .PID or .ECD file. If you are viewing both PID and ECD files, both file types will be saved with the same name and corresponding extension.

   For example if you viewing a file that contains a chromatogram from the PID and from the ECD and you save the file with the name TEST, two files will be saved: TEST.PID and TEST.ECD

3. Enter a file name or use the existing file name.

4. Select the drive and directory to which the file will be saved.

5. Click **Save**.

Printing an Analysis Report

To print an analysis report:

1. Select the Instrument tab.

2. Connect Voyager to the computer and ensure communication has been established with the instrument.

3. Perform a run.

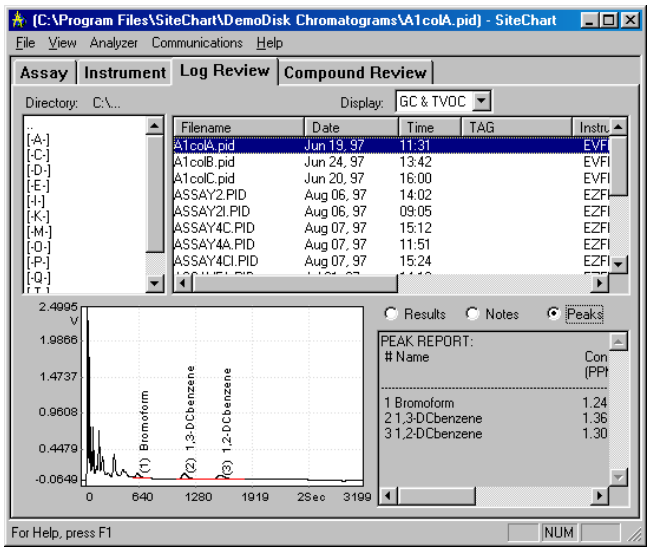
4. When the analysis is complete, open the File menu and select **Print** (***Alt, F, P***).

5. When the Print dialog box opens, check your print settings. Ensure your printer is configured correctly.

6. Click **OK** to print the analysis.

The analysis report includes results, method, integration method, notes and a peak report. A chromatogram is also printed. The chromatogram is printed as it appears on the screen. If the graph has been normalized it will be printed in the normalized view.

The Log Review Tab



Once data has been acquired from Voyager, it can be reviewed using the Log Review tab. This tab allows you to scroll through and review, completed runs stored in the datalogger of a particular instrument. When the instrument is connected to SiteChart, the contents of the datalogger are automatically downloaded to SiteChart. All analyses received from an instrument will be stored in the data sub-directory selected during installation of SiteChart. SiteChart was designed to accept data from multiple instruments so the log directory is divided into sub-directories. Each sub-directory corresponds to information received from a single instrument. These sub-directories are created using the instrument serial numbers. For example, if one instrument has the serial number “123”, then all the information received from this instrument will be recorded in a sub-directory of the data directory called “123”. The path would be c:\Program Files\SiteChart\Data\123\filename.PID.

Log Listing

To generate a log listing:

1. Select the type of files to be reviewed from the Display drop-down list box. You can view GC files, TVOC files or both GC and TVOC files.

2. In the Directory box, double-click to select the drive and directory where your Voyager files are stored. In this directory, there should be a sub-directory corresponding to the serial number of the instrument. Select this sub-directory. The Log Review list to the right of the Directory box will list all the recorded analyses. The log listing includes the following information:

Field Name	Description
Filename	The name of the stored analysis. SiteChart generates file names, you can change the file name using the Save As command in the File menu.
Date and Time	The date and time the run was started.
TAG	The tag used to identify a certain run or group of runs.
Instrument	The instrument serial number.
Column	The column used.
Detector	PID or ECD.
Assay	Assay number 1 to 7.
Peaks	The number of integrated peaks.
Status	The status of the peaks. Ratio-metric calibration may lead to an invalid calibration and is intended for specialized applications only.

Each one of these fields can be sized.

To resize a field:

1. Move the mouse to the edge of the field. The pointer will change into a double-headed arrow.

2. Press the left mouse button and drag the arrow to set the field to the desired size.

Update Log Listing

If the instrument is connected to the computer and is performing runs, completed runs will be added to the current directory. If you are reviewing data from the current directory, SiteChart will update your log listing whenever a run is added to the directory. This could be a time consuming task if you have a long list of files. To prevent the list from being updated automatically, you can disable this feature.
To disable automatic update feature:

1. Open the View menu and select **Auto Update Log Listing**.
   The check mark will disappear and new runs will be logged to the computer but will not be added to the log review list.

2. To manually update your log listing, open the View menu and select **Update Log Listing**.

File Name Format

All files are saved in a unique name.extention format, where the name is an 8-character string.

XYMMDD##.EXT	
X	The column on which the analysis was run. Will be A, B, C or V.
Y	The last digit of the current year.
MM	The current month (01 is January, 12 is December)
DD	Current Day
##	Unique identification number to differentiate between runs performed on the same date. Run numbers start at 00.
EXT	.PID, .ECD, .VOC

To sort the log listing, click on the column header on which to sort. The column will be automatically sorted alphabetically, or numerically.

NOTE: *This could be a time consuming process, depending on the speed of your computer.*

Log Review

You can scroll through the listing and select a file to review.

1. Use the mouse to select a file.

   When the file is selected the chromatogram is displayed. You can review the method, notes or the peak report for the analysis in the box to the right of the chromatogram.

2. A pop-up menu, with the View menu options, is displayed by moving the mouse into the graph area and clicking the right mouse button (right-clicking).

   See *Reference Chromatogram* on page 117 for details of viewing the chromatogram.

3. Move the mouse pointer over any peak in the chromatogram to obtain information about the peaks in the chromatogram.

   Leave the cross-hair over the peak and an information box will pop-up. The box contains the peak name, retention time and the integrated area.

4. You can modify the selected analysis by re-integrating or adding notes.

   If you modify the analysis, it is automatically saved.

Each file in the log represents a single run. If an assay requires 2 detectors and 3 runs to complete an analysis, then the results for the assay will be spread across 6 files.

Printing the Log Review File

To print the log review file:

1. Create the log listing as outlined in the previous section.

2. From the File menu select **Print Log Repor**t (***Alt***, ***F***, ***L***).

You can also print an analysis report for a selected file:

1. Select the file for which you want the analysis report.
2. From the File menu select **Print** (***Alt***, ***F***, ***P***).

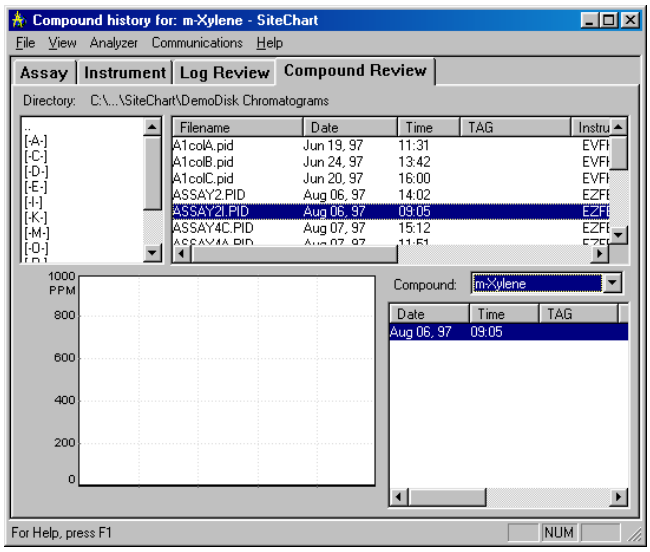
Saving the Log Review File

Saving the log file will create an ASCII comma delimited file. You can import this file into spreadsheet applications such as Excel™.

To save a log file:

1. Create the log listing as outlined in the previous section.
2. From the File menu select **Save As** (***Alt***, ***F***, ***A***).
3. Enter a name for the log file.
   The file will be saved as a SiteChart log file with the extension .log.
4. Select whether or not you want the file created as a read-only file.
5. Click **Save**.
   The comma delimited log file cannot be opened in SiteChart.

Compound Review Tab



To analyze the results on the basis of a single compound, use the Compound Review tab. This tab allows you to generate a graph of concentrations for a specific compound over a range of runs.

Compound Concentration Graph

To create a concentration versus run graph:

1. In the Directory box, select the drive and directory where your Voyager files are stored. In this directory, there should be a sub-directory identified by the serial number of the instrument. Select this sub-directory.

2. The Log Review list to the right of the Directory box will list all the recorded analyses.

   The compound review list is the same as the log review listing. See the table below for a description of each field in the listing.

3. If necessary size the fields accordingly.

4. Select the analyses for which a compound report is required. Use the extend select feature by pressing, and holding, the SHIFT key. Select the first run and the last run in the range.

5. Wait for a few seconds while the hour glass is displayed. Select the compound list.

   A drop-down list box will appear displaying a list of all compounds that are present in at least one of the selected analyses.

6. Select the desired compound.

   The compound table will be filled with every occurrence of the compound in the selected analyses. The graph will be drawn based on the data in the compound table.

7. If the order in which the data is displayed is not suitable, you can sort the data. Click on the header of the column you want to sort.

   The table, and graph, will be updated to reflect the sorted data.

Field Name	Description
Date	The date the run was started
Time	The time the run was started
TAG	The tag used to identify a certain run or group of runs
Concentration	The detected concentration
Height (mV)	The peak height.
Area (mVS)	The integrated area. This is determined from the integration method.
Column	The column used for the run

Detector	PID or ECD
Status	The status of the peaks. Ratio-metric calibration may lead to an invalid calibration and is intended for specialized applications only. Please contact the Applications Department for more details.

By selecting a row in the compound table, the corresponding bar, in the graph, is highlighted. Conversely, by selecting a bar in the graph, the corresponding row in the compound table will be highlighted. This is useful when viewing a graph and table with many entries.

Right-clicking on the graph will open the View Pop-up menu. All options available to this graph will be displayed. See *View Pop-up Menu* on page 117 for details.

Update Compound Listing

If the instrument is connected to the computer and is performing runs, completed runs will be added to the current directory. If you are reviewing data from the current directory, SiteChart will update your compound listing whenever a run is added to the directory. This could be a time consuming task if you have a long list of files. To prevent the list from being updated automatically, you can disable this feature.

To update your compound listing:

1. Open the View menu and select **Auto Update Log Listing**.
   The check mark will disappear and new runs will be logged to the computer but will not be added to the compound review list.

2. To manually update your compound list, open the View menu and select **Update Log Listing**.

Save the Compound Review File

Saving the log file will create an ASCII comma delimited file. You can import this file into spreadsheet applications such as Microsoft Excel™.

To save a compound report:

1. Create the log listing as outlined in *Compound Review Tab* on page 145.
2. From the File menu, select **Save As** (***Alt***, ***F***, ***A***).
3. Enter a name for the log file.
   The file will be saved as a SiteChart log file.
4. Select whether or not you want the file created as a read-only file.
5. Click **Save**.
   The comma delimited file log file cannot be opened in SiteChart.

Printing the Compound Review File

To print a compound report:

1. Create the log listing as outlined above.
2. Select the files from the listing to be included in the compound listing.
3. Select the compound of interest from the drop-down list box.
4. From the File menu, select **Print Log Report** (***Alt***, ***F***, ***L***).

SiteChart Menus

File Menu

The File Menu allows you to open and save assays and data files, convert to and from standard GC file formats, print data and log reports, and exit SiteChart.

New

The **New** command allows you to create assays. The **New** command is available when the Assay tab is selected.

To create a new assay in SiteChart:

1. Open the File menu and select **New** (***Alt***, ***F***, ***N***).
   SiteChart will ask whether or not an electron capture detector (ECD) is installed in your instrument.
   A new file is created with no information in any of the tabs.

2. Load a chromatogram from which you can add compound information to the library or perform a run, save it and add compound information from the new chromatogram. See *Adding Compounds to the Library* on page 175.

Use **New** when you want to create a new assay, without having to delete all the existing library compounds. Normally, you will load an existing assay, modify and test it and then save it as a new assay.

Open

Use the **Open** command to open and display an assay, or a sample file. The **Open** command is available to the Assay.

To open an assay:

1. Click on the Assay tab or the Compound Review tab.

2. From the File menu select **Open** (***Alt***, ***F***, ***O***).
   SiteChart will show application (.app) and method (.apm) files.

3. Select the required type of files to be displayed in the **Files of Type** drop-down list.

4. Select the correct drive and directory.

5. Select the file and click **Open** or double-click on the file name to open the file.

   OR

   You can also enter a specific file name.
   You must also enter the correct path so SiteChart can locate the file. For example, you can type c:\mydocs\test.app. If you do not know the file name, use * as a wildcard. For example, type "*.app", to see a list of all application files on the specified drive and directory.
   The Column/Detector option will display Column A-PID and the Library will display the Column A-PID library list. This is the default option. If a sample file (PID or ECD) was saved with the application, then it is also displayed.

NOTE: *The chromatogram may not correspond to the selected column.*

To open a PID or ECD sample file:

1. Click on the Assay tab.

2. In the **Files of Type** drop-down list select the required type of detector: **ECD Samples**, **PID Samples**, or **All Samples**.

3. Select the directory to which you copied your assay disks.

4. Select the file and click **Open** or double-click on the file.
   The sample information for the selected chromatogram is displayed.

Save and Save As

To update an existing file:

1. Click on the Assay tab or Instrument tab.
2. Open the File menu and select **Save** (***Alt***, ***F***, ***S)***.

To save a new file or save an existing file to a new location:

1. Click on the Assay tab or Instrument tab.
2. Open the File menu and select **Save As** (***Alt***, ***F***, ***A***).
   If you clicked on the Assay tab, SiteChart will save the file as a .app. If you were in the Instrument tab, SiteChart will save the file as a .PID or .ECD file.
3. Enter a file name or use the existing file name.
   Limit your file names to 10 characters. Site Chart will add the appropriate extension.
4. Select the drive and directory to which the file will be saved.
5. Click **Save**.

Print

Use the **Print** command to obtain printed reports. The type of report printed will depend on which tab is selected when you select the **Print** command.

To print an assay report:

1. Select the Assay tab.
2. Load the assay to be printed.

3. Open the File menu and select **Print** (***Alt***, ***F***, ***P***).

   The Print dialog box opens. You must install and configure your printer through Windows Control Panel. Refer to the Windows documentation for details.

4. If you have installed more than one printer, select the desired printer and click **OK**.

   An assay report will be printed. The assay report contains all the information from the Assay tab.

To print an analysis report:

1. Select the Instrument tab.
2. Connect Voyager to the computer and ensure communication has been established with the instrument.
3. Perform a run.
4. When the analysis is complete, open the File menu and select **Print** (***Alt***, ***F***, ***P***).
5. When the Print dialog box opens, check your print settings. Ensure your printer is configured correctly.
6. Click **OK** to print the analysis.

To print an analysis report for files that have been saved:

1. Select the Log Review tab.
2. Select the directory in which your files are saved.

   The .PID or .ECD files will be displayed.
3. Select the file to be printed.
4. Open the File menu and select **Print** (***Alt***, ***F***, ***P***).

5. When the Print dialog box opens, check your print settings. Ensure your printer is configured correctly.

6. Click **OK** to print the analysis.

The analysis report includes results, method, integration method, notes and a peak report. A chromatogram is also printed. The chromatogram is printed as it appears on the screen. If the graph has been normalized it will be printed in the normalized view.

Print Setup

The **Print Setup** command allows you to configure the printer from within SiteChart.

1. Open the File menu and select **Print Setup** (***Alt***, ***F***, ***R***).

2. Ensure the correct printer is selected and that it is configured correctly.

3. Select the size of the sheet on which the reports will be printed.
   SiteChart reports have been designed to fit a letter or legal size sheet.

4. Select the paper orientation.
   Reports can be printed in portrait or landscape.

The properties button opens another dialog box that provides more information specific to the printer. Refer to your printer user's manual for more information on the settings in this dialog box.

Recent File 1, 2, 3, 4

Use the numbers and file names listed to open the last four files you used. Choose the number that corresponds with the document you want to open. If the file has been moved since it was last saved, SiteChart will display an error message. You must then use the **Open** command to locate and open the file.

Exit

Choosing **Exit** will terminate SiteChart.

To exit SiteChart:

1. From the File menu, choose **Exit** (***Alt F, X*** or ***Alt F4***).

   If any changes have been, a warning window will open explaining the application will close and give you a chance to return to the program.

2. Click **Yes** to close SiteChart and save all files that have been changed, or click **No** to close the application without saving.

   If no changes have been made the application will close immediately.

View Menu

The View menu allows you to manipulate the display, turn on/off the status block, control the display font size, reintegrate the display, control the peak labels, update the log listing, turn on/off the Status Bar and the Instrument Status display.
The View menu commands are also available by clicking the right mouse button on the main graph area in any tab. A pop-up menu is displayed listing the relevant View menu commands. Click on a command, with the left mouse button, to select it. To remove the menu, click anywhere but on the menu bar.

Previous Zoom

This option displays the previous zoom of the display.

To zoom in on the display:

1. Click on the display, outside the area of interest, and drag the mouse over the area of interest.

   The rectangle created by dragging the mouse will be expanded to fill the complete display.

2. Continue zooming in as desired.

To zoom out on the display:

1. Click **Previous Zoom**.

2. Continue clicking on the Previous Zoom command as required.

3. To view the complete graph, click **Auto Range**.

Grid

The **Grid** command turns the reference grid on/off. The grid on the graph of the current tab will be affected.

➢ To turn the grid on/off, click **Grid**.

Auto Range

Auto Range will automatically select a range that is appropriate for the signal level in the analysis.

If you have used the zoom feature to enlarge the graph, use **Auto Range** to view the complete graph.

Normalize

The **Normalize** command will scale the current view of the chromatogram so that the minimum signal is aligned with the bottom of the display, and the maximum signal is aligned with the top of the display.

➢ Select **Auto Range** to return to the full-scale view.

Smooth

Smoothing effectively removes or reduces unwanted noise by averaging every point on the signal with several points before and several points after. The result is a much smoother baseline and may result in better integration if noise was affecting peak detection.

To smooth a chromatogram:

1. Open the chromatogram to be modified.

2. From the View menu, select **Smooth**.

3. Select the amount of smoothing to be applied.

   The signal will be smoothed and the modified chromatogram is displayed. **None** provides no smoothing and **15** provides the maximum smoothing. If you select **15**, SiteChart averages 7 points before and 7 points after every point on the baseline.

4. From the View menu, select **Re-integrate**.

   If signal noise was affecting integration, signal smoothing will lead to more accurate integration.

5. Annotate the notes for this chromatogram, to show that the original file has been modified, and then save it.

   You can always return to the original chromatogram by setting smoothing to **None**.

Status Block

This command enables/disables the status block. The **status block** displays the signal level and the slope of the signal at a time defined by the position of the cross-hair. The cross hair does not need to be directly on the signal.

Font Size

Selects the font size for the labels on the graph. **Automatic** is always readable. It adjusts the font size with the current view. **Small**, **Medium**, and **Large** allow you to customize the displayed font as required.

Re-integrate

The **Re-integrate** command recalculates the area of the peak using the new integration parameters or new library information.

When you re-integrate, the integration method from the current assay is used. If an assay has been loaded from another instrument, the serial number will not correspond to the analysis. SiteChart will display a warning message. You can override this message, but use caution. The reported results may be invalid.

Integration Method

The options in the Integration Method dialog box allow you to view or alter the integration method. After you change any of the integration parameters, the chromatogram will automatically be re-integrated so you can see the effect of the new integration values. The Integration Method is used to determine the compound peaks and calculate the peak area. All of these parameters are set as part of the method. Refer to *Integration Method* on page 188 and the assay notes before making changes to the integration method.

When **Automatic Integration** is enabled the software automatically selects the Slope Up and Slope Down values and minimum height based on a sampling of the signal at the start of a run. Ensure **Automatic Integration** is selected. Refer to *Integration Method* on page 161 for details on the integration method before adjusting any of the integration parameters.

Peak Labels

Peak Labels selects the peak labels that are displayed on the graph. **None** displays no peak labels. The **Numbers** option will number each integrated peak. **Labels** will display the peak name if the peak can be identified**. Names and Numbers** display a number and the peak name.

Update Log Listing and Auto Update Log Listing

If the instrument is connected to the computer and is performing runs, completed runs will be added to the current directory. If you are reviewing compound or log data from the current directory, SiteChart will update your listing whenever a run is added to the directory. This could be a time consuming task if you have a long list of files. To prevent the list from being updated automatically, you can disable this feature.

To disable the Auto Update feature:

1. Open the View menu and select **Auto Update Log Listing**.

   The check mark will disappear and new runs will be logged to the computer but will not be added to the listing.

2. To manually update your listing, open the View menu and select **Update Log Listing**.

Enable the Auto Update Log Listing feature if you need to maintain a current log or compound review listing.

While the computer is trying to update compound or log review listings it may lose communication with the instrument. If this happens SiteChart will display a message indicating that it has lost its connection to the instrument and will immediately attempt to re-establish communications with the computer. To avoid this, disable Auto Update Log Listing and update the compound and log review listings manually.

Status Bar

The **Status Bar** command shows or hides the status bar. The status bar is located at the bottom of the screen and displays the status of the application. Three windows on the far right of the bar indicate the status of the scroll lock, the num lock and the caps lock keys.

You can view a brief description of each SiteChart option in the status bar. The **Status Bar** must be turned on. Point at any menu or menu item and hold down the left mouse button. To avoid activating the button, continue to press the mouse button. Drag the mouse pointer away from the menu or menu item and then release the mouse button.

Turn the status bar off to provide more viewing area.

Instrument Status

The **Instrument Status** command shows or hides the instrument status display in the Instrument tab. Close the instrument status block to enlarge the view of the chromatogram and the peak report.

Analyzer Menu

Setup

The **Setup** command allows you to enter a tag and provides access to the auto cycle settings.

A tag may be used to identify a certain sampling location or a certain sample in the datalogger. You can enter a tag to indicate a change of location, a change in personnel or a change in method.

To enter a tag:

1. Open the Analyzer menu and select **Setup**.
2. Enter a tag.
   The tag can use up to 10 characters.
3. Click **OK** to confirm the tag.

The tag you enter here will identify both GC and TVOC analyses. You can enter a new tag for every analysis or you can enter a single tag for a group of analyses.

Auto Cycling Operation

Auto operation allows you to set up Voyager to take samples automatically. You must use loop injections for auto analyzing. If more than one column is required to complete an analysis, then each column will be sampled in order. If each column has different chromatographic settings, Voyager will adjust its settings between analyses. You can also configure the instrument to perform a preset number of analyses.

Auto cycling is the only way to cycle through multiple columns as required for an analysis if you are operating Voyager from SiteChart. If you click **Start** on the Instrument tab or select the **Start** and **Stop** commands from the Analyzer menu, SiteChart will begin an analysis on the selected column. If you click **Start** again, the analysis will again be on the selected column. To switch columns, you must select another column and then click **Start**.

To configure your instrument for auto cycling operation:

1. Ensure Voyager is set up correctly. Carrier gas must be supplied to the instrument. It must be displaying a ready status.

2. Select the Assay tab and ensure the correct assay is loaded.

3. Select the Instrument tab and select the column on which to begin auto cycling.

4. Open the Analyzer menu and select the column or right-click on the column graphic in the instrument status box to open a column selection pop-up menu.

5. Connect a sample to the sample inlet port or allow Voyager to draw a sample of room air.

6. Open the Analyzer menu and select **Setup**.

7. Enter a delay time.

   This is the time between runs. A minimum delay of 1 minute is required to enable Voyager to stabilize the baseline.

8. Enter the number of runs required.

   If your method requires all three columns and you need 2 complete analyses, enter 6. After 6 runs, 2 on each column, Voyager will turn auto analyzing off. If you want the instrument to sample continuously enter 0. If you are analyzing continuously, ensure that you have connected Voyager to the AC adapter and an external supply of carrier gas. Check the **Auto Cycle** box and then click **OK**.

   Voyager will begin auto cycling.

If you have selected a preset number of runs to be performed, SiteChart will turn off the auto cycling option when it has completed the runs. If you are cycling Voyager continuously, you must turn auto cycling off from the Analyzer menu.

9. In the Analyzer menu, select **Setup**. De-select the Auto Cycle check box and click **OK**.

   Auto cycling will stop when the analysis in progress is complete.

Integration Method

The options in the Integration Method dialog box allow you to view or alter the integration method. After you change any of the integration parameters, the chromatogram will automatically be re-integrated so you can see the effect of the new integration values. The Integration Method is used to determine the compound peaks and calculate the peak area. All of these parameters are set as part of the method. Refer to *Integration Method* on page 188 and the assay notes before making changes to the integration method.

When **Automatic Integration** is enabled the software automatically selects the Slope Up and Slope Down values and minimum height based on a sampling of the signal at the start of a run. Ensure **Automatic Integration** is selected.

Parameter	Description
Slope Up	The minimum slope required to start a peak.
Slope Down	The minimum slope required to stop a peak.
Minimum Height	Any peak with a height less than the minimum height will not be included in the peak report.
Minimum Area	Any peak with an area less than the minimum area will not be included in the peak report.

Integration Delay	Delays the start of the timer. Any peak eluting before the timer starts will not be included in the peak report.
Filter Level	Determines the amount of filtering to apply to the signal. Filter 1 provides the most filtering.

Column

The **Column** command allows you to select the column for the next run on Voyager. The selected column will remain enabled until it is de-selected. This command over-rides the column sampling sequence on the instrument and forces the run to be performed on the column selected here. The run will be performed using the chromatographic settings for the selected column as set by the current assay.

Start and Stop

The **Start** command starts a Voyager run. Before beginning a run, ensure Voyager has been set up correctly. Carrier gas must be supplied to the instrument.

To stop the analysis before it is complete, use the **Stop** command. If you stopped the analysis after the sample was injected onto the column you must wait for the duration of the analysis time for the column to be flushed before beginning another analysis on the same column. When you stop an analysis, Voyager will begin to flush the column and move to the next column.

Calibrate

The **Calibrate** command calibrates Voyager using the last analysis.

To calibrate the instrument:

1. Perform a run on the first column required by the assay.
   The run must include all library compounds specific to the selected column. Refer to the assay notes supplied with your assay for details.

2. When the run is complete, review the chromatogram and peak report to ensure that all compounds have been detected and that the reported concentrations are correct.

3. Select the Assay tab and ensure all library concentrations are correct.

4. Open the Analyzer menu and select **Calibrate**.

   SiteChart will calibrate Voyager. The Voyager library will be updated accordingly. Voyager is now calibrated and ready for operation.

   The information in the SiteChart library will not be updated. Each time you load a new assay and download it to the instrument, you must calibrate the instrument in order to update the current library information.

Service

The **Service** command displays a window that shows the Voyager display. This can be used to troubleshoot instrument problems remotely. This command allows you to access all Voyager functions from your computer.

NOTE: *Voyager cannot be powered up from this window. If Voyager is powered down, then you must turn it on by pressing the **On/Off** button on the instrument.*

The buttons control Voyager in the same manner as the keys on Voyager.

Communication Menu

The Communications menu allows you to setup communications between the computer and the instrument.

The communication pull-down menu has the following options:

- **Setup** allows you to configure which serial port will be used to connect the instrument to the remote computer.

- **Dial Out** allows you to dial out to the specified number and establish communication with a remote computer. This feature will allow you to dial out to a remote instrument from SiteChart.

- **Alarm Dial** sets the computer, controlling Voyager, to dial a second computer in the event of an alarm or fault condition.

- **Hang Up** terminates the modem session that is currently in progress.

SiteChart can connect to one Voyager. In order to connect two instruments, you must run two copies of SiteChart. You will also need a second serial port. If you do not need to control two instruments at the same time, you may want to connect one instrument to the computer, download the information, disconnect it and then connect the second instrument.

Connecting Multiple Instruments

1. Start SiteChart and connect the communications cable to the first Voyager.

2. Open the Communications menu and select **Setup**.

3. Select the serial port to which the first Voyager is connected.

4. Ensure the first instrument is communicating with SiteChart.

5. Start another copy of SiteChart and connect the communications cable to the second Voyager.

6. Open the Communications menu and select **Setup**.

7. Select the serial port to which the second Voyager is connected.

8. Ensure the second instrument is communicating with SiteChart.

SiteChart was designed to accept data from multiple instruments so the log directory is divided into sub-directories. Each sub-directory will correspond to information received from a single instrument. These sub-directories are created using the instrument serial numbers. For example, if one instrument has the serial number "123", then all the information received from this instrument will be recorded in a sub-directory of the data directory called "123". The path would be C:\Program Files\SiteChart\Data\123\filename.PID.

Remote Connection Hardware Configuration

This option allows you to setup Voyager at the monitoring site. You will setup the computer at a remote location and communicate with the Voyager through a modem. You must have a modem for Voyager and another modem for the computer. A modem capable of transmitting at 9600 baud is required. A faster modem is recommended.

To configure your system for remote communication:

1. Connect the modem to the Voyager using the communication cable (Part No. MX380304).

2. Turn Voyager on and ensure carrier gas is connected or that the internal reservoir is full.

3. Connect the modem to the phone line.

4. Ensure the modem is turned on and is working properly.

5. Connect the second modem to a serial port on the computer.
   If you need to add another serial port, refer to the computer's manual for detailed instructions.

NOTE: *The modem must be connected to a serial port.*

6. In the Communication menu, select **Setup**.
   The Setup command allows you to configure the computer to communicate with Voyager either directly or through a modem.

7. Select the serial port to which the modem is connected.

8. Connect the modem to the phone line.

9. Ensure the modem is turned on and is working properly.

Initiating Remote Communications

1. Enter the phone number at which the Voyager and its modem are connected.

   You can type parentheses and dashes, but they are not required. Type commas to provide any delays required before the number is processed by the telephone system.

   If you are using a Hayes™ compatible modem with the default settings, each comma inserts a delay of approximately 2 seconds.

   If you are not using a Hayes™ compatible modem, the delays and the characters that create the delays may be different. Refer to the modem user's manual.

2. Press the Dial button to initiate communication.

3. Monitor the modem status in the Dial Out dialog box. When the modem has successfully connected with Voyager, you can close the dialog box.

4. Select the Instrument tab and check the instrument status box.

   The current values from Voyager will be displayed.

You can now control the instrument from the computer. You can turn Voyager off from the computer but you cannot turn it on again. Voyager must be powered up from the local keypad by pressing the **On/Off** key.

Terminating Communication

When you are ready to terminate communication with Voyager:

- Open the Communication menu and select **Hang up**.

  SiteChart will issue the command to the modem and disconnect the modem from the telephone line.

  You can also click **Hang Up** in the Dial Out dialog box. You can see the modem status messages in this dialog box.

You can turn Voyager off from the computer but you cannot turn it on again. Voyager must be powered up from the local keypad by pressing the **On/Off** key.

Alarm Dial

You can setup the computer to dial out to a remote computer if an alarm or fault condition is encountered.

If the computer is connected directly to Voyager you must connect a modem to a free serial port in order to use this feature.

If you are controlling Voyager from a remote location, you will need a second modem connected to a free serial port on the computer. Ensure the modems are connected and configured correctly.

To configure your system to dial out on an alarm condition:

1. Select **Alarm Dial** from the Communications menu.

2. Enter the telephone number to which the computer should dial if an alarm or fault condition is encountered.

3. Select the port to which the modem is connected.

   If Voyager is connected directly to the computer this will be the modem port. If you are controlling Voyager from a remote location, this will be the second modem port.

4. Check **Dial on Alarm** or **Dial on Fault** condition or both as required.

5. Click **OK** to close the dialog box.

If any of the conditions you selected occur, the computer will dial out to the preset number. SiteChart will try to establish communication and send a message indicating that an alarm or fault has occurred. Test the feature to ensure all connections are correct and that all information has been entered correctly.

Help Menu

To get help quickly as you work, press the F1 key. When the Help window appears you can display a procedure for a particular task, or see information about any command.

You can view Help side by side with a window in which you are working so that both windows remain visible while you work.

The Help index provides an index of available Help topics. Select the desired topic and it will be displayed in the Help window. You can get context-sensitive Help as you work. For example if you are in the Save As dialog box, press **F1** to display Help information about the options.

If you have a question about SiteChart and cannot find the answer in this manual or in the on-line Help, you can contact the PerkinElmer Photovac Technical Support for assistance. If you call, you should be sitting in front of your computer with SiteChart running and the chromatogram in question open on the screen. You should also have this manual at hand.

Whether you call or write, please provide the following information:

- The version number of Windows and the version number of SiteChart.
  In the Help menu, select the About command to determine the software version number.
- The type of hardware you are using, including network hardware, if applicable.
- A description of what happened and what you were doing when the problem occurred.
- The exact wording of any messages that appear on the screen.
- Voyager's serial number.

Help Topics

When **Help Topics** is selected, you can choose to view the contents of the help file or to look at an index.

To view the on-line help:

1. Selecting **contents** will display a list of SiteChart menus and tabs.

2. Double-click on the menu or tab for which you need more information.
   A Help window will open providing basic information about the topic.

➢ If **Index** is selected, another window will open which lists an index of the help file. Enter the topic for which you require help and click **Display**.

If you are running Windows 95 you also have the option to generate a database listing of the help file. This allows you to search for information using words and phrases rather than by category.

1. Select the **Find** command and create the database.

2. Create the database to minimize size, maximize search capabilities or customize the process. Refer to the Windows documentation for more details.

About SiteChart

About SiteChart displays the SiteChart software version number. You will need to know the version number if you are calling PerkinElmer Photovac Technical Support for information about SiteChart.

5 *Method Development*

Method Development Using SiteChart

Assay development can be approached in two ways: first, you can develop a custom assay based on the compounds that are included as part of the assay that has been shipped with your instrument. Second, you can develop your own library of compounds.

If you use the first method, all the required chromatographic settings for each compound are stored and the only steps required are selecting the compounds of interest and calibrating the instrument. Each library listing has been setup for a specific application. The compound groups and the associated chromatographic settings have been selected to obtain the best results. Refer to the assay notes for details.

If you use the second method, you have complete control of the GC. You can adjust any of the chromatographic settings, such as temperature and flow rate and optimize the analysis for your compounds of interest. However, you must enter all your compound information, as the information in the reference library becomes invalid. Once your method has been entered you can save it and update the information as necessary.

Library

The library is specific to an assay. If you have obtained Assay 1, for example, then you will have a library of approximately 40 compounds from which you can develop your custom assay. The library is loaded as part of the assay.

A library is supplied for each column/detector pair required for the assay. The number of libraries is determined by the assay. The compound information in the libraries has been determined by the standard method. The libraries are always available on the assay disk so you can use the original method and the information in the reference library.

If your chromatographic settings have not changed from the original assay, but library compounds are not correctly identified or not identified at all, they may have drifted out of the peak recognition window. You can update library information based on a recent chromatogram that has been run using the original assay. See *Compound Library* on page 120. Changes made to the current library are not made to the reference library.

Column Selection

Each assay contains three columns. Each column has a library of compounds and their associated chromatographic information. Refer to the assay notes to determine which is the best column on which to run your compounds. If the compounds of interest must be run on two columns, you must perform two runs to complete an analysis and two runs to calibrate the instrument. See *Column/Detector Selection* on page 116.

An ECD is available for Voyager that is configured for Assay 1. You must have the ECD installed to access the ECD options. In the Instrument tab, select the PID, the ECD or both.

You can set the PID to high sensitivity for low concentrations, or for compounds that do not respond well to a PID. Select low sensitivity for high concentrations. The PID sensitivity is equivalent to the detector gain. See *Detector State* on page 187 for details or setting the PID sensitivity. Refer to the assay notes for guidelines on setting the gain.

To select the required column/detector combination:

1. Select the Assay tab.

2. Select the desired column/detector pair from the drop-down box.

The library for the selected column will be displayed in the library box.
Any changes you make to the method apply to the currently selected column only. If you need to change the setting for another column, select the next column/detector pair and make the necessary changes.

Adding Compounds to the Library

One compound library is supplied for each column/detector pair, as part of each assay. These libraries have been determined for the assay standard method.
If the method is modified, a new library must be created, identifying the compounds with their new retention times. You must run an analysis of the compounds and then add them to the library.

Adding Compounds

1. Select the Assay Tab.

2. Optimize the method for your compounds. If your method requires more than one column/detector combination, optimize the chromatography for each column/detector pair.

   Refer to the assay notes to determine which chromatographic settings will provide the best separation for your compounds.

3. Save the new assay.

NOTE: *When the method is changed, the reference libraries are no longer valid and will automatically be deleted from the assay.*

4. Ensure Voyager is on and ready for operation and then send the information to Voyager by clicking **Send to Voyager**.

5. Connect a sample to the Sample In port and begin a run.

6. When the analysis is complete, select the Assay tab. If necessary zoom in on the chromatogram to view the peaks.

7. Double-click on the first peak that you want to add or click **Add** in the Library box.

   A dialog box opens.

8. Enter the correct name and concentration.

   Limit your compound name to 20 characters. Note that Voyager will display only 15 characters of the compound name.

9. Review the data in the library information box. Compounds present in the calibration gas must be selected for calibration. Compounds not present in the calibration gas must be removed.

NOTE: *All compounds contained in the library must be contained in the calibration gas.*

10. Ensure you have entered the correct calibration concentration.
    This is the concentration of the compound in your calibration gas.

11. Select whether you want the concentration averaged over multiple calibration runs.
    See *Calibration Averaging* on page 125 for details.

12. Enter an Alarm level.

13. Enter the Window percent.
    The Window Percent is the deviation in retention time for which Voyager will compensate. For example, if the window is set at 5%, a compound with a retention time of 100 seconds will still be identified if it elutes between 95 and 105 seconds.

14. Select how you want the peak identified: as the Largest peak in the window or as the Closest retention time in the library.
    If there are interference compounds, that appear at the same retention time, but are not as responsive to the PID or are present in very low concentrations, then select Largest peak in the window. If the interference compound is close in detector response, but has a different retention time, then select closest retention time.

15. Select the desired Curve Fit option.
    See *Calibration Curve* on page 126 for details.

16. If possible run the compound at more than one concentration. Use **Store** to store up to five concentration values for a compound. Best response results will be obtained this way.
    See *Multiple Point Calibration Curve* on page 178 for details.

17. Double-click on the next peak in the chromatogram or click **Add** in the Library box and enter the information as outlined above. Repeat this process for all peaks in the chromatogram.

18. Once all the peak information has been entered, move the mouse to the graph and click the right mouse button. Select **re-integrate** from the pop-up menu that opens.

    The chromatogram will be re-integrated using the new library information.

19. If your compounds of interest require another column/detector option, select the next column/detector pair and run another analysis.

20. Store the compounds as described above. Repeat this procedure for a third column/detector pair if necessary.

Saving the New Assay

Save the assay file so that you do not lose any of your changes. Save the assay with a new name so that you do not overwrite the original assay.

To save a newly created assay:

1. From the File menu select **Save As** (***Alt***, ***F***, ***A***). If you are updating a file you use the **Save** option (***Alt***, ***F***, ***S***).

2. Enter a name for the assay.

   The file will be saved as a SiteChart assay with the extension .app.

3. Select whether or not you want the file created as a read-only file.

4. Click **Save**.

Multiple Point Calibration Curve

Multiple point calibration will provide the most accurate response. If you have a gas dilutor or you have standards at more than one concentration, store multiple points to get a more accurate calibration curve.

To create a multiple point calibration curve:

1. Select the Assay Tab.
2. Select the column/detector combination required for your compound. Ensure your compound is already listed in the library.
3. Ensure Voyager is on and ready for operation.
4. Connect a sample to the Sample In port and begin a run.
5. When the analysis is complete, select the Assay tab. Open the file that was just run.
   The chromatogram will be displayed in the window
6. Double-click on the peak in the chromatogram and enter the concentration.
   Normally, you will use a linear calibration curve.
7. Select **Linear** and SiteChart will update the calibration curve to incorporate the new point.
8. If you have more than one compound at a different concentration then repeat the procedure for the other peaks in the chromatogram.
9. Perform another run at another concentration and store the compound. Repeat this procedure for all available concentrations.
10. If you need to remove a concentration point, select the point in the area/concentration table and click **Erase**.
    During calibration, the single point that is contained in the calibration gas is used to update the curve.

Analysis Settings

Developing your own method allows you to optimize the system for your particular application. If, for example you want to run benzene, toluene and m-xylene (BTX) as quickly as possible you can increase the pressure, increase the temperature and decrease the analysis time.

When you make any changes to the analysis settings, the reference library will be invalid. The retention times for library compounds become invalid when you change any of the analysis parameters. The reference library is still available on the disk supplied with the instrument. It will not be accessible from SiteChart unless you load it from the disk again.

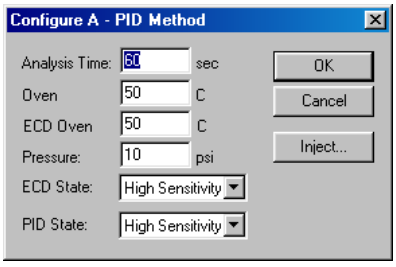
You may have to perform a few runs in order to optimize your method. Once you have obtained well-separated peaks at the desired analysis time then you can store the compounds in the library.

Analysis Time

Analysis time is the duration of the analysis. You must set the analysis time so that all compounds of interest clear the column and pass into the detector. Refer to the assay notes to determine the correct analysis time for your application.

To set the analysis time:

1. Select the Assay tab.
2. In the Method box, click **Config**.
   The Configure dialog is displayed.



3. Enter the desired **Analysis Time** and click **OK** to accept the change and close the dialog box.

   The change you have made applies to the currently selected column only. If you need to change the setting for another column, select the next column and change the analysis time.

4. Save the assay.

Backflush Time

The analysis time consists of the foreflush time and the backflush time. During foreflush the sample is injected onto the column and is allowed to clear the precolumn. When the compounds of interest have cleared the precolumn, backflush begins. Set the backflush time so that all your compounds of interest clear the precolumn. Perform a few runs to ensure that compounds of interest enter the analytical column, but contaminant compounds are backflushed.

You can enter the backflush time as a function of the other method parameters. By entering as a function, the backflush time will be updated accordingly when any of the function parameters are changed. Enter the backflush time as a function of analysis time (A), pump time (P), injection time (I) . For example backflush time = (A+P)/3. If the analysis time or pump time are modified the backflush time is also updated.

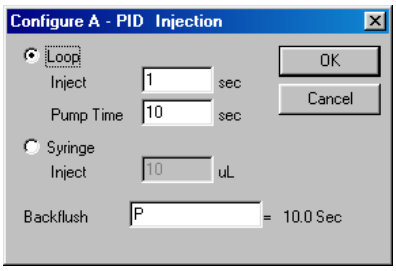
To set the backflush time:

1. Select the Assay tab.

2. In the Method box, click **Config**.

3. Click **Inject**.

   The Injection dialog is displayed.



4. Enter the desired **Backflush** time and click **OK** to accept the change and close the dialog boxes.

   The change you have made applies to the currently selected column only. If you need to change the setting for another column, select the next column and change the backflush time.

5. Save the assay.

Pump Time

The Pump Time is the duration the pump draws sample through the SAMPLE IN port to flush and fill the sample loop. Set the pump time so that the sample loop is allowed to flush with the sample before the sample is injected.

When Voyager changes the PID sensitivity (gain), it must monitor and change the offset. This occurs during the pump time. Voyager begins to adjust the offset at about 8-10 seconds into the pump time. Typical setting for the pump time do not allow sufficient time for baseline stabilization after the extreme changes in offset that occur during gain switching.

If it is necessary to switch gains between runs, set the pump times to at least 20 seconds. Use typical times of 10 to 15 seconds when no gain switching is required.

To change the detector sensitivity:

1. Select the Assay tab.

2. In the Method box, click **Config**.

3. Click **Inject** in the Configure dialog box.

4. Ensure **Loop** is selected and enter the desired **Pump Time**.

5. Click **OK** to accept the changes and close the dialog boxes.

   The change you have made applies to the currently selected column only. If you need to change the setting for another column, select the next column and change the pump time.

6. Save the assay.

Injection Type

Samples can be introduced by automatic loop injection or by manual syringe injection. If you select loop injection you must also set an injection time. Injection time determines how long the loop will be in line with the column and in turn what volume will be injected onto the column. The injected volume will also depend on the flow rate. For example, setting the injection time to 10 seconds, at a pressure of 15 psi, will inject the entire contents of the sample loop onto the column.

Voyager is a very sensitive instrument. It is easy to overload the column and detector by injecting a sample that is too large. Normally, you will set the injection time to between 0.4 and 2 seconds. The flow rate and injection time will determine the volume of sample injected from the 0.5 ml sample loop.

Voyager is not designed to accept liquid injections, so water samples are analyzed using the headspace above standards. You may obtain commercially prepared standards or you can prepare the headspace standards.

CAUTION

Do not inject liquid samples into Voyager or you will damage it.

To select the injection method:

1. Select the Assay tab.
2. In the Method box click **Config**.
3. Click **Inject** in the Configure dialog box.
4. Select **Loop** or **Syringe**.
5. If you selected **Loop**, ensure the correct pump time and inject time have been entered.

   OR

   If you have selected **Syringe** injection, enter the injection volume.
   This information is for report purposes only. You will determine the actual injection volume at the time of injection.
6. Click **OK** to accept the changes and close the dialog boxes.
   The change you have made applies to the currently selected column only. If you need to change the setting for another column, select the next column and change the injection method.
7. Save the assay.

Injection Volume

The injection volume (syringe) is for report purposes only. You will control the actual injection volume, with the syringe, at the time of the injection. Use the microliter syringe supplied with the calibration kit (Part No. MX380310) to inject small volumes. Voyager is a very sensitive instrument. It is easy to overload the column and detector by injecting a sample that is too large.

To set the injection volume:

1. Select the Assay tab.
2. In the Method box, click **Config**.
3. Click **Inject** in the Configure dialog box.
4. Ensure **Syringe** is selected.
5. Enter the **Inject** volume.
6. Click **OK** to accept the changes and close the dialog boxes.
   The change you have made applies to the currently selected column only. If you need to change the setting for another column, select the next column and change the injection volume.
7. Save the assay.

NOTE: *Voyager is not designed to accept liquid injections, so water samples are analyzed using the headspace above standards. You may obtain commercially prepared standards or you can prepare the headspace standards.*

CAUTION

Do not inject liquid samples into Voyager or you will damage it.

Oven Temperature

In isothermal operation the columns and the PID are maintained at a fixed temperature. Retention time drift is virtually eliminated and faster analysis results are obtained with less frequent calibration.

The smaller the difference between ambient temperature and instrument operating temperature of the column, the quicker the column will reach thermal equilibrium and the lower the power consumption will be. However, if a temperature difference is too small, the ambient temperature may increase above that of the column and the column will no longer be under isothermal control. An Oven Temp fault will be displayed.

You can set the temperature to between 0 and 80 °C. Set the temperature to 0 to turn the oven off.

NOTE: *Do not set the temperature to below 50°C, as samples may condense on the column and contaminate your system.*

To set the oven temperature:

1. Select the Assay tab.
2. In the Method box, click **Config**.
3. Enter the desired **Oven** temperature.
4. Click **OK** to accept the changes and close the dialog box.
   The change you have made applies to the currently selected column only. If you need to change the setting for another column, select the next column and change the temperature.
5. Save the assay.

NOTE: *If you have entered different temperatures for each column, Voyager will require 30 minutes between analyses for the column to reach temperature equilibrium.*

ECD Temperature

The ECD temperature can be set independently of the column and the PID. The ECD must be maintained at a temperature greater than or equal to the column/PID temperature.

NOTE: *Do not set the ECD temperature less than the column temperature. It is possible the sample could condense and contaminate the radioactive foil contained in the ECD.*

To set the ECD temperature:

1. Select the Assay tab.
2. In the Method box, click **Config**.
3. Enter the desired **ECD Oven** temperature.
4. Click **OK** to accept the changes and close the dialog boxes.
   The change you have made applies to the currently selected column only. If you need to change the setting for another column, select the next column and change the injection volume.
5. Save the assay.

NOTE: *If you have entered different ECD temperatures for each column method, Voyager will require 30 minutes between analyses for the ECD to reach temperature equilibrium.*

Pressure

When adjusting the carrier gas flow rates ensure the flow through the detector is maintained at a constant rate. Variations in the detector flow will result in baseline instability, especially with high sensitivity applications. After you change the pressure, allow a few minutes for the flow through the columns to stabilize. You can set the pressure to any value between 8 and 14 psi.

To set the column pressure:

1. Select the Assay tab.

2. In the Method box, click **Config**.

3. Enter the desired **Pressure**.

4. Click **OK** to accept the changes and close the dialog boxes.
   The change you have made applies to the currently selected column only. If you need to change the setting for another column, select the next column and change the pressure.

5. Save the assay.

Detector State

An ECD is available for Voyager configured for Assay 1. You must have the ECD installed to access the ECD options. In the Instrument tab, select the PID, the ECD or both.

You can set the PID to high sensitivity for low concentrations, or for compounds that do not respond well to a PID. Select low sensitivity for high concentrations.

To change the detector sensitivity:

1. Select the Assay tab.

2. In the Method box, click **Config**.

3. Enter the desired **PID State** and/or **ECD State**.

4. Click **OK** to accept the changes and close the dialog boxes.
   The change you have made applies to the currently selected column only. If you need to change the setting for another column, select the next column and change the detector state.

5. Save the assay.

When Voyager changes the PID sensitivity (gain), it must monitor and change the offset. This occurs during the pump time. Voyager begins to adjust the offset at about 8-10 seconds into the pump time. Typical setting for the pump time do not allow sufficient time for baseline stabilization after the extreme changes in offset that occur during gain switching.

If it is necessary to switch gains between runs, set the pump times to at least 20. Use typical times of 10 to 15 seconds when no gain switching is required. See page 181 for details on setting the pump time.

Integration Method

General Information

The integrator extracts information from the detector signal. The integrator has been designed to reduce or eliminate the user input required for good chromatographic integration.

Chromatographic peaks are identified according to the following recognition sequence based on the slope of the signal coming from the detector. The integrator looks for each step to occur in sequence.

To detect a peak the integrator goes through the following steps:

1. The slope exceeds a threshold value for a certain time period.
   When this occurs, the peak has started.

2. The slope goes negative for a time period.
   This indicates the peak maximum has been detected.

3. At this point the height of the peak can be calculated.
   If it is greater than the Minimum Height value in the Integration Method then the sequence is continued, otherwise the peak is disregarded and the integrator goes back to step 1.

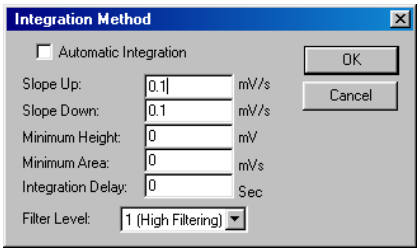
4. The slope, now negative, rises above a threshold value for a certain time period.
   The end of the peak has been detected.

Peak retention times are measured when the slope changes from positive to negative (the peak maxima).

Peak areas are calculated by summing the area slices beneath the signal and subtracting the area below the line connecting the start and end points.

If Automatic Integration is enabled, Voyager will enter the values automatically in the Integration Method dialog box in the Analyzer menu. You can enter the Up/Down Slope and Minimum Height values if automatic integration is disabled. The slope is calculated from a five point moving average and is compared with the effective Up and Down Slope sensitivities to start and stop the integrator.

➢ To set up the integration, select **Integration Method** from the Analyzer menu. The Integration Method dialog is displayed.



Automatic Integration

For most analyses automatic integration will give the best results. If, however, the signal is not representative during the five second period, then the peak recognition factors Up Slope, Down Slope and Minimum Height may not be calculated correctly for the chromatogram. In this case it may be necessary to set the integration parameters manually.

The choice of initial Up/Down Slope and Filter can require some expertise. Voyager automates this procedure as the Up/Down Slope, Minimum Height, and Filter options are set automatically if automatic integration is enabled.

These parameters are calculated on the basis of signal noise sampling during the first five seconds of an analysis. During the first five seconds of an analysis, Voyager samples the signal at a frequency of approximately 15 Hz. The integrator uses linear regression to determine the best line through these sample points. The sample scatter is then used to determine the Minimum Height. The slope of each group of five sample points is then calculated. The scatter of the slopes is used to determine the Up and Down Slope sensitivities.

Up/Down Slope

The slope of the signal is calculated once each averaging period as a weighted average of the slopes from 2 periods behind and two periods ahead. This is the 5 point moving average.

To start the integrator, the calculated slope must exceed the Up Slope settings once and then remain greater than the half of the Up Slope (>Up Slope/2) setting for the next four averaging periods. The integrator looks for four consecutive points so that noise is not mistaken for a peak.

For example: if the Up slope sensitivity has been set to 2 mV/S then Voyager looks for a slope greater than or equal to 2 mV/S. When it finds a slope greater than or equal to this value, then it looks for four more consecutive positive slopes. If it finds them, then it returns to the initial slope greater than 2 mV/S and sets this at the integration start point.

The integrator locates the peak maximum and the retention time by looking for the first negative slopes and then four more negative slopes. Once it has data that meet the criteria, it goes back and assigns the first negative slope as the peak maxima and assigns this point as the retention time.

The integrator is stopped if five consecutive slopes are more positive than the Down slope setting. The integrator is looking for a flattening trend. If Down Slope is set to 2 mV/S this is effectively -2 mV/S. The integrator is looking for a slope of -2 mV/S and then four more slopes greater than or equal to -2 mV/S.

If peaks are not being integrated properly, the slope settings may be adjusted to provide more accurate integration. If the peak is ending too soon, decrease the Down Slope setting so that the integrator is looking for a smaller slope. If the end of the peak cannot be found, then increase the Down Slope setting.

Minimum Height

The Minimum Height is required for comparison in the basic peak recognition sequence. Although single Up/Down Slope and Minimum Height values are displayed the integrator will operate on the same data with four different filters simultaneously since it does not know critical information such as peak widths. It then selects the best result based on identifying the maximum number of significant peaks.

Set the minimum height based on the detector response to the smallest peak. Peaks that do not meet the minimum height will not be integrated and thus will not be included in the peak report.

Minimum Area

Set the minimum area based on the detector response to the smallest peak. Peaks that do not meet the minimum area will not be included in the peak report. These two options are used to eliminate baseline disruptions that have been mistakenly identified as compound peaks.

Integration Delay

Use the integration delay option to delay the start of the integration timer. This can be useful if your analysis contains more than 25 peaks. SiteChart and Voyager can identify 25 compounds at a time. If you are interested in the first 25 peaks set the delay time to 0. If you are interested in peaks that elute later in the analysis, set the delay to 60 seconds, or an appropriate delay for your analysis time, so that the first peaks are ignored and the 25 peaks eluting after 60 seconds will be identified and displayed.

If you need to identify all the peaks in the run, then set the delay to 0 and print an analysis report. Then set the delay to 60, or an appropriate delay for your analysis time and re-integrate the run. Then, print another analysis report.

If you are using a PID with nitrogen carrier gas, you will see a negative peak due to oxygen in your sample. Set the integration delay so that the timer begins after this negative peak. If you are using the ECD this oxygen peak will be positive.

Filter

Since baseline noise is constant throughout the chromatogram, the reduced slope sensitivities may allow false noise peaks to be detected. To reduce these effects, the integrator filters the signal by averaging the signal over larger periods while reducing the slope sensitivities. This allows the signal to noise ratio to remain constant throughout an analysis giving good integration on both early and late peaks. It is not possible to select a single filter that will work ideally under all conditions, because of variations in carrier flow and column temperature in a GC. If data are too heavily filtered, adjacent peaks will not be resolved, while if too lightly filtered, noise creates unwanted peaks. In either case the quality of the integration will suffer. Filter 1 provides the most filtering with the signal being averaged over the longest period before the slope is calculated. Filter 4 provides the most versatility; the signal is analyzed simultaneously by four different filters.

The highest filter level is used to detect the start of each peak. Once a peak is detected 1, 2, 3 or 4 of the other filters (depending on the Filter selected) will operate on the same data until they detect integration stop points.

The end result is detection of large peaks since all data are heavily filtered as well as good resolution of small peaks since all data are also analyzed with relatively little filtering. When the signal noise is low, select Filter 4. For noisier signals, select lower Filter numbers. Filter 4 also provides better resolution for co-eluting peaks.

Merged Peaks

Merged peaks are separated in one of two ways. Voyager will draw either a diagonal or vertical line depending on where the peaks overlap.

Again, as with normal peaks, when the integration stops, the area below the baseline is subtracted and the resulting peak areas are stored for calculation.

Sometimes a peak is discovered which trails off the falling edge of a much larger peak. In this case dropping a perpendicular baseline would overestimate the area of the second peak. To compensate for this, a simple baseline, directly connecting the start and stop points of the second peak is used. The area beneath the baseline is allocated to the preceding (or primary) peak. The method of drawing in the baseline for the second peak is called a tangent skim. The criteria for skimming a peak are:

Equation 1: $t_1/t_2 > 4$

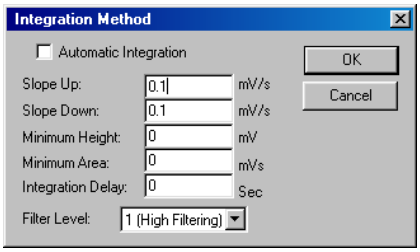
Equation 2: $H_1/H_2 > 2$

where t = the time between the peak maxima and the valley between the two peaks and H = the height of the peak.

Setting Integration Parameters

To set the peak recognition factors:

1. Select **Integration Method** from the Analyzer menu.
   The Integration Method dialog is displayed.



2. The **Slope Up** factor determines what the integration start point will be.
   If Up Slope is set to 6 mV/S, then the integrator will look for the signal level to rise at a rate of for 6 mV/S one sample and at least 3 mV/S for four samples. Up Slope can be any value from 0.1 to 99 mV/S. Typically values between 0.5 and 5 mV/S are used.

3. Enter a value for the **Slope Down** sensitivity.

   The Down Slope factor sets the point where the integration will end and determine the area under the peak. This value can also range from 0.1 to 99. Again typical values are set between 0.5 and 5 mV/S.

   The Up and Down Slope sensitivities set here will be used by Voyager as default values. If Auto is selected Voyager will select its own values based on the best results it can obtain for the current analysis. These values depend on the amount of baseline noise and may change for every chromatogram.

4. The **Integration Delay** is used to delay the start of integration after the analysis begins. It is used to prevent integration of peaks which may appear as a result of pressure changes during sample injection, especially when large syringe injections are made. If there are no pressure peaks, set the integrator delay to zero. If you have more than 25 peaks in an analysis, integrator delay may be used to determine which 25 peaks will be identified. If you are interested in the peaks in the middle or at the end of the chromatogram, set the integrator delay so that the first peaks are not used.

5. The **Minimum Area** is the minimum integrated area that must be detected in order for Voyager to identify a compound and put it in the Peak Report. When creating a method set the Minimum Area Factor to 0 initially so that all peaks will be identified.

   Peaks that do not meet the minimum area requirements will be labeled Unknown.

6. The **Minimum Height** is the minimum peak height that will be accepted as a sample peak.

   This factor allows the integrator to eliminate peaks due to noise.

   If manual integration is being used adjust the Minimum Height up or down from the value set by the integrator to obtain the desired results.

7. **Filter 1** provides the most filtering with the signal being averaged over the longest period before the slope is calculated. **Filter 4** provides the most versatility; the signal is analyzed simultaneously by four different filters.

   The filter with the highest filtering is used to detect the start of each peak. Once a peak is detected, 0, 1, 2, or 3 of the other filters (depending on the Filter selected) will operate on the same data until they detect integration stop points.

8. The displayed chromatogram will be automatically re-integrated using the new settings.

Assay Properties

Assay properties provide access to the features that complete the development of an assay. These properties will be set as part of your assay. You will only need to change these parameters if you are creating your own assay.

Assay Notes

Assay notes are displayed when you open an assay. The notes allow you to enter a brief description of the assay. Normally you will list the intended application. You can also add any warnings or limitations of usage as required.

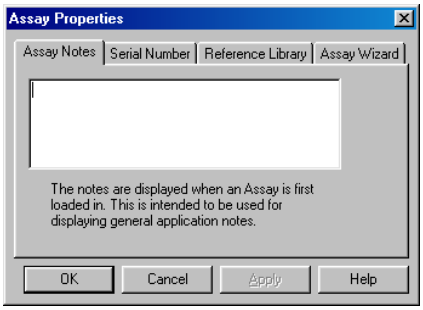
Serial Number

Assays are normally created for a single instrument. Although method information may be transferred from one instrument to another, variations in retention time and response may result in lower sensitivity or compound misidentification.

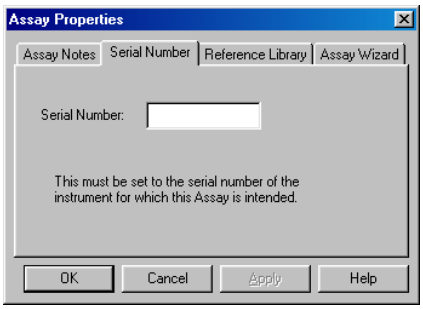
Assays are created for specific instruments. When you have created an assay you can link the assay to a specific instrument. This information will be saved as part of the assay. If you attempt to download the assay to a different instrument, a warning message will be displayed.

To link an assay to a specific instrument:

1. Open the View menu and select **Properties**.
   The Assay Properties dialog is displayed.



2. Select the serial number tab.



3. Enter the Voyager **Serial Number**.
   The serial number must be from the instrument that you used to create the assay.

If assays created on one instrument are downloaded to a second instrument you must update the library on the second instrument as outlined in *Updating Library Information* on page 121. You must also calibrate the second instrument.

Reference Library

There are two options on this tab. Enter the default window percent to be used when compounds are added to the library. This is the retention time window that SiteChart will use in an attempt to match the peak with existing reference library compounds. For example, if the window is set at 50%, and you try to add a peak with a retention time of 100 seconds, SiteChart will list compounds with retention times from 50 seconds to 150 seconds as possible matches. Only compounds that have not already been identified will be listed. Compounds within the retention time window will be listed in the Add dialog box that opens when you double-click on an unknown peak. See *Adding Compounds to the Library* on page 175.

The second option on this tab allows you to copy the current library to the reference library. You can use this feature to create your own assays.

To create your own reference library:

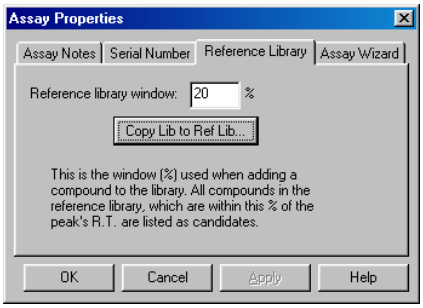
1. Create a library by storing compounds as outlined in *Adding Compounds to the Library* on page 175.

   You can also use the existing library and update the compound information as described in *Updating Library Information* on page 121.

2. Perform a few runs and ensure your library information is correct.

3. Open the View menu and select **Properties**.

4. Select the Reference Library tab.


Assay Properties
Assay Notes
Serial Number
Reference Library
Assay Wizard
Reference library window:
20
%
Copy Lib to Ref Lib...
This is the window (%) used when adding a compound to the library. All compounds in the reference library, which are within this % of the peak's R.T. are listed as candidates.
OK
Cancel
Apply
Help

5. Click **Copy Lib to Ref Lib**.

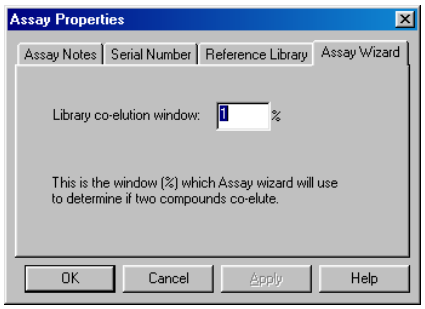
6. Save the assay with a new name.

NOTE: *Do not overwrite the reference library supplied with your assay.*

Assay Wizard

The window percent in this tab determines the co-elution window. If you set the window percent to 10%, compounds with retention times within 10% of each other will be identified as a co-elution and Assay Wizard will warn you.

Before setting this parameter, you may want to perform a few runs to ensure you can obtain good separation and good integration. Peaks that cannot be reliably separated, identified and quantified must be identified as a co-elution.



Method Development Using Voyager Directly

Developing your own method allows you to optimize the system for your particular application. If for example you want to run benzene, toluene and m-xylene (BTX) as quickly as possible, you can increase the pressure, increase the temperature and decrease the analysis time.

Normally you will access most of the options covered in this section using the SiteChart software as described in *Method Development Using SiteChart*, starting on page 173. A brief description of each function and how to change the settings is provided to allow you to make changes to the method when SiteChart is not available.

NOTE: *Changes made to the method using Voyager directly cannot be saved to disk. The changes will be lost when a new method is loaded.*

One or more methods will be provided with your assay. Use SiteChart to load the required method.

You must put Voyager into supervisor mode in order to access all the options covered in this section. In supervisor mode, all the user mode commands are available and advanced method development features are also accessible.

1. Press **Enter Menu**, SETUP, MODE. Use the arrow keys to select Super.

2. Press **Enter Menu** and **Exit**.
   A password is required to change from user mode to supervisor mode. The password is factory set and cannot be changed. The password is 12344321.

3. Press **Enter Menu**.
   You are now in supervisor mode.

Selecting Columns and Detectors

Information specific to your assay is provided in the user notes supplied with your assay. Information such as column coating or packing material and column length will help you to determine which column to use for your application. A list of assay compounds and their associated chromatographic settings is also provided, in the user notes, to aid in the selection of a column for a specific application.

A detector is also selected as part of the method. If you compounds are better suited to ECD detection, then select a method that utilizes the ECD. If you have co-elutions on the PID, you can run a sample using the ECD and the PID. If both detectors are selected the column effluent is split. Part of the sample is sent through the ECD and the rest is sent through the PID. Using this method you can obtain two chromatograms from the sample.

If the compounds of interest must be run on two columns, you must perform two runs to complete an analysis and two runs to calibrate the instrument. If the compounds of interest must be separated on all three columns, you must perform three runs to complete an analysis and three runs to calibrate the instrument. Enable only the columns that you require for your application. You must select the column in combination with a detector. Select the PID or the ECD. The ECD is only available for Assay 1.

1. Press **Enter Menu**, SETUP, CONFIG, and COLUMN. Use the arrow keys to select the column/detector combination and press **Enter Menu** to confirm the selection.

   The ECD options are located below the PID options. Press the DWN ARROW to select the ECD options.

   You can select both PID and ECD column combinations. If you have selected PID Column B and ECD Column B a run on Column B will be put through both detectors. You can view the output from one detector at a time.

2. Select one, two or all three columns and associated detectors.

3. Press **Exit** to close the box.

4. Press **Enter Menu** to close the menu.

5. If you have selected the ECD, you must set it up.

6. To change the view from the PID to the ECD, press DISPLAY, STATUS, GC, DET. You will be prompted to change views to the ECD.

7. Press **Enter Menu**.

   Use this option to switch back to the PID view.

If you are using one of the methods supplied with your assay, each column will have associated chromatographic settings. You can modify these settings to suit your application or you can use the existing settings.

Assay development can be approached in two ways: first, you can develop a custom assay based on the compounds that are included as part of the assay that has been shipped with your instrument. Second, you can develop your own library of compounds.

You can set the PID to high sensitivity for low concentrations, or for compounds that do not respond well to a PID. Select low sensitivity for high concentrations. The ECD has one sensitivity setting.

1. Press **Enter Menu**, SETUP, CONFIG, SENSE.

2. Use the arrow keys to select the high sensitivity option for your columns.

   If the high sensitivity option is not selected, then the detector is operating at low sensitivity.

Adding Compounds to the Library

If you need to add compounds to your library, you need to run an analysis of the compounds and then add each compound to the library. Although you can add compounds to Voyager directly using the following procedure, we recommend using SiteChart to create and modify library information. If you have prepared a library on the instrument there is no way to save it. It will be lost when another method is loaded. If the library is created in SiteChart you can save it as part of a custom method for later use. It can then be downloaded to Voyager at any time.

1. Refer to the user notes supplied with your assay to determine which columns will provide the best separation for your compounds. You may require two or possibly all three columns. If your method requires two or more columns you must repeat this procedure for each column.

2. Select one column/detector combination and disable the other two columns.

3. Press **Enter Menu**, then LIBRARY.
   The library for the selected column will be displayed.

4. Delete any compounds that are not required for your assay.

5. Press LIST, EDIT, STORE, EDIT. You will be prompted for a Peak No. Enter **0** to delete the peak from the library.

6. Press DISPLAY, GC, GRAPH.
   This will display the chromatogram so you can see the compound peaks. You can also use the peak report display.

7. Connect a sample to the sample in port and begin a run.
   If you are performing a syringe injection, prepare the syringe sample and inject it at the beep. You may have to do a few runs in order to optimize your method. Once you have obtained well separated peaks at the desired analysis time then you can store the compounds in the library.

8. When the analysis is complete, press LIBRARY, LIST, EDIT, STORE.

9. Use the arrow keys to enter the peak number of the peak you want to store. Press **Enter Menu**.

10. Use the arrow keys to enter the compound name. Press **Enter Menu**.

    This will be the first concentration stored for this compound. This box will allow you to store the compound at multiple concentrations.

11. Press **Enter Menu** to confirm. Press **Exit** to close the box.

12. Use the arrow keys to enter the concentration of the compound. Press **Enter Menu** to confirm.

13. Use the arrow keys to enter the size of the window.

    The Window size is the deviation in retention time for which Voyager will compensate. For example, if the window is set at 10%, a compound with a retention time of 100 s will still be identified if it elutes at anytime between 90 and 110 seconds.

14. Select the desired curve fit option.

    Line segments will join the calibration points you enter and use this as the calibration curve. **Linear** will use linear regression to find the best line through the calibration points you store. **Quadratic** will determine the best quadratic function to fit your stored concentration points. **Cubic** will use a third order function to fit your data.

15. Press **Enter Menu** and then press **Exit** to close the box.

16. Press ALARM and use the arrow keys to enter an alarm concentration.

    If the detected concentration exceeds this alarm level, an alarm will be generated.

17. Press CALCMPD.

    A check will appear beside the compound name to indicate the compound is selected for calibration.

18. Review the information in the calibration box to ensure all the information has been entered correctly.

19. Repeat this procedure for the other compounds to be stored in this library.

20. If possible run the compounds at more than one concentration. Use STORE to store up to five concentration values for a compound.

    Best response results will be obtained this way.

21. Once all the peak information has been entered, press **Enter Menu**, DISPLAY, GC, GRAPH, REINT to re-integrate the chromatogram.

    Voyager will use the new library information to identify the peaks.

22. If your compounds of interest require another column option, select the next column and run another analysis. Store the compounds as outlined above.

23. Repeat this procedure for a third column if necessary.

Analysis Settings

NOTE: *Changes made to the method, using Voyager directly cannot be saved to disk. The changes will be lost when a new method is loaded.*

Analysis Time

Analysis time is the duration of the analysis. You must set the analysis time so that all compounds of interest clear the column and pass into the detector. Details of how to set the analysis time are provided in the user notes specific to your assay.

To change the analysis time:

1. Press **Enter Menu**, SETUP, CONFIG, COLUMN.
2. Select the column for which you want to alter the analysis time. Disable the other columns.
3. Press **Exit** to close the box and then **Enter Menu**.
4. Press **Enter Menu**, SETUP, CONFIG, METHOD, TIMING, and ANLZ.
5. Use the arrow keys to enter the new analysis time.
6. Press **Enter Menu**.
7. If you need to change the analysis time for the other two columns, repeat this procedure for each column.
8. When you have changed the analysis time for each column, enable all the columns required for your method.

Backflush Time

The analysis time consists of the foreflush time and the backflush time. During foreflush the sample is injected onto the column and is allowed to clear the precolumn. When the compounds of interest have cleared the precolumn, backflush begins. Set the backflush time so that all your compounds of interest clear the precolumn. Perform a few runs to ensure your compounds of interest are not backflushed. Details of how to determine the backflush time are provided in the user notes specific to your assay.

To change the backflush time:

1. Press **Enter Menu**, SETUP, CONFIG, COLUMN.
2. Select the column for which you want to alter the backflush time. Disable the other columns.
3. Press **Exit** to close the box. Press **Enter Menu** to close the menu.
4. Press **Enter Menu**, SETUP, CONFIG, METHOD, TIMING, and BCKFLSH.
5. Use the arrow keys to enter the new backflush time. Press **Enter Menu**.
6. If you need to change the backflush time for the other two columns, repeat this procedure for each column.
7. When you have changed the backflush time for each column, enable all the columns required for your method.

Pump Time

The pump time is the duration the pump draws sample through the sample in port to flush and fill the sample loop. You must increase the pump time if you are using a long probe or an extended probe. Set the pump time to between 20 and 45 seconds. The pump time for the probe is set automatically when you select the probe to be used:

1. Press **Enter Menu** and then press SETUP, MODE, INJECT.

2. Press PROBE. Use the up and down arrow keys to select the desired probe.

   The short probe is a 6" (15 cm) Teflon probe. The long probe is the three meter sample line. The telescoping sample probe is 2 m long and has an extension handle.

3. Press **Enter Menu** to confirm your selection and then press **Exit** to close the box and return to the menu.

4. Press **Enter Menu** to close the menu.

If you need finer control of the pump time you can adjust the time to suit your method. Another consideration when setting the pump time is the PID sensitivity. When Voyager changes the PID sensitivity (gain), it must monitor and change the offset. This occurs during the pump time. Voyager begins to adjust the offset at about 8-10 seconds into the pump time. Typical setting for the pump time do not allow sufficient time for baseline stabilization after the extreme changes that occur during gain switching.

If it is necessary to switch gains between runs, set the pump times to at least 20. Use typical times of 10 to 15 seconds when no gain switching is required.

1. Press **Enter Menu**, SETUP, CONFIG, COLUMN.

2. Select the column for which you want to alter the pump time. Disable the other columns.

3. Press **Exit** to close the box. Press **Enter Menu** to close the menu.

4. Press **Enter Menu**, SETUP, CONFIG, METHOD, TIMING, and PUMP.

5. Use the arrow keys to enter the new pump time. Press **Enter Menu**.

6. If you need to change the pump time for the other two columns, repeat this procedure for each column.

7. When you have changed the pump time for each column, enable all the columns required for your method.

If minimizing the pump time is critical for your application, you must confirm correct offset adjustment.

1. Set the pump time to 10 seconds.
   This is the minimum value for the pump time.

2. Perform 3-4 analyses on each active column. For each analysis, monitor the signal level at the end of the pump time.
   The baseline should be approximately 2 mV if the PID sensitivity is set to high and approximately 200 mV if the PID sensitivity is set to low.

3. If the baseline has not been set correctly, then the pump time is too short. Increase the pump time and repeat this procedure.

NOTE: *If your method incorporates a switch in gain between analyses, then the pump time must be set to 20 seconds.*

Injection Time

Injection time determines how long the sample loop is in line with the column and in turn, the volume of the sample that is injected onto the column. Injection time has no effect on syringe injection. Setting the injection time to 10 seconds will inject the entire contents of the sample loop onto the column. The volume of the sample loop is 0.5 mL.

Voyager is a very sensitive instrument. It is easy to overload the column and detector by injecting a sample that is too large. Normally, you will set the injection time to between 0.4 and 2 second. You may want to start with a short injection time, perform a run and increase it to obtain the best results.

1. Press **Enter Menu**, SETUP, CONFIG, COLUMN.

2. Select the column for which you want to alter the injection time. Disable the other columns.

3. Press **Exit** to close the box. Press **Enter Menu** to close the menu.

4. Press **Enter Menu**, SETUP, CONFIG, METHOD, TIMING, and INJECT.

5. Use the arrow keys to enter the new injection time. Press **Enter Menu**.

6. If you need to change the injection time for the other two columns, repeat this procedure for each column.

7. When you have changed the injection time for each column, enable all the columns required for your method.

Column Temperature

In isothermal operation the columns are maintained at a fixed temperature. Retention time drift is virtually eliminated and faster analysis results are obtained with less frequent calibration. The PID is maintained at the same temperature as the columns.

NOTE: *Do not set the temperature to below 40°C, as samples may condense on the column and contaminate your system.*

1. Press **Enter Menu**, SETUP, CONFIG, COLUMN.
2. Select the column for which you want to alter the column temperature. Disable the other columns.
3. Press **Exit** to close the box. Press **Enter Menu** to close the menu.
4. Press **Enter Menu**, SETUP, CONFIG, METHOD, TEMP, and COLUMN.
5. Use the arrow keys to enter the new column temperature. Press **Enter Menu**.

   Voyager will allow you to set the temperature to between 0 and 80 °C. It is not advisable to set the column temperature to less than 40 °C.
6. If you need to change the column temperature for the other two columns, repeat this procedure for each column.
7. When you have changed the column temperature for each column, enable all the columns required for your method.

If you have entered different temperatures for each column, Voyager will require 20 to 30 minutes between analyses to reach the column temperature.

ECD Temperature

WARNING

Voyager equipped with an ECD is not classified for use in hazardous locations.

The ECD temperature can be set independently of the column and the PID. The ECD must be maintained at a temperature greater than or equal to the column temperature.

NOTE: *Do not set the ECD temperature less than the column temperature. It is possible the sample could condense and contaminate the radioactive foil contained in the ECD.*

1. Press **Enter Menu**, SETUP, CONFIG, COLUMN.
2. Select the column for which you want to alter the column temperature. Disable the other columns.
3. Press **Exit** to close the box. Press **Enter Menu** to close the menu.
4. Press **Enter Menu**, SETUP, CONFIG, METHOD, TEMP, and ECD.
5. Use the arrow keys to enter the new column temperature. Press **Enter Menu**.
   Voyager will allow you to set the temperature to between 0 and 80 °C. It is not advisable to set the ECD temperature to less than 40 °C.
6. If you need to change the column temperature for the other two columns, repeat this procedure for each column.
7. When you have changed the column temperature for each column, enable all the columns required for your method.

If you have entered different temperatures for each column, Voyager will require 20 to 30 minutes between analyses to reach the ECD temperature.

Pressure

When adjusting the carrier gas pressure, ensure the flow through the detector is maintained at a constant rate. Variations in the detector flow will result in baseline instability, especially with high sensitivity applications. After you change the pressure, allow a few minutes for the flow through the columns to stabilize. You can set the pressure to any value between 0 and 14 psig.

Adjusting the pressure will effect all flow rates. For example if you increase the pressure, the maintenance flow through the idle columns and the make-up flow through the ECD (if it is installed) will also increase.
A higher pressure will result in increased flow rates but decreased operating time from the internal cylinder. You may have to refill the internal cylinder more frequently.

1. Press **Enter Menu**, SETUP, CONFIG, COLUMN. Select the column for which you want to alter the pressure. Disable the other columns.

2. Press **Exit** to close the box. Press **Enter Menu** to close the menu.

3. Press **Enter Menu**, SETUP, CONFIG, METHOD and PRESS.

4. Use the arrow keys to enter the new column head pressure. Press **Enter Menu**.

5. If you need to change the pressure for the other two columns, repeat this procedure for each column.

6. When you have changed the column pressure for each column, enable all the columns required for your method.

If you have entered different pressures for each column, Voyager will require approximately 5 minutes between analyses to adjust the flow rates and stabilize.

Integration Method

Normally, you do not need to alter the integration parameters. Setting these parameters can require some expertise. You will need to perform a few runs to ensure accurate integration. You may be able to obtain better integration by smoothing the signal:

1. Press **Enter Menu**, DISPLAY, GC, GRAPH AND SMOOTH.
   The signal will be smoothed.

2. Press SMOOTH again to further smooth the signal.

3. Press REINT, to re-integrate the chromatogram.

If you cannot obtain accurate integration using the preset integration parameters, then you will have to modify the existing parameters.
The integrator extracts information from the detector signal. The integrator has been designed to reduce or eliminate the user input required for good chromatographic integration.

Chromatographic peaks are identified according to the following recognition sequence based on the slope of the signal coming from the detector. The integrator looks for each step to occur in sequence.

1. When the slope exceeds a threshold value for a certain time period, the peak has started.

2. The slope goes negative for a time period.
   This indicates the peak maximum has been detected.

3. At this point the height of the peak can be calculated.
   If it is greater than the Minimum height value in the Integration Method then the sequence is continued, otherwise the peak is disregarded and the integrator goes back to step 1.

4. The slope, now negative, rises above a threshold value for a certain time period. The end of the peak has been detected.

Peak retention times are measured when the slope changes from positive to negative (the peak maxima).

Peak areas are calculated by summing the area slices beneath the signal and subtracting the area below the line connecting the start and end points.

Up Slope, Down Slope and Filter

The slope of the signal is calculated from a five point moving average and is compared with the effective up and down slope sensitivities to start and stop the integrator.

Since baseline noise is constant throughout the chromatogram, the reduced slope sensitivities may allow false noise peaks to be detected. To reduce these effects the integrator filters the signal by averaging the signal over larger periods while reducing the slope sensitivities. This allows the signal to noise ratio to remain constant throughout an analysis giving good integration on both early and late peaks. Filter 1 provides the most filtering with the signal being averaged over the longest period before the slope is calculated. Filter 4 provides the most versatility; the signal is analyzed simultaneously by four different filters as with auto-integration. When the signal noise is low, select Filter 4. For noisier signals, select lower Filter numbers.

To change the settings:

1. Press **Enter Menu**, SETUP, CONFIG, COLUMN.

2. Select the column for which you want to alter the integration settings. Disable the other columns.

3. Press **Exit** to close the box. Press **Enter Menu** to close the menu.

4. Press **Enter Menu**, SETUP, CONFIG, METHOD, ∫METH, and SLOPES.

5. Select the parameter you want to change. Press SLP UP.

   The up slope factor determines what the integration start point will be. If up slope is set to 6 mV/S, then the integrator will look for the signal level to rise at a rate of at least 6 mV/S for five consecutive samples. Up slope can be any value from 1 to 99 mV/S. Typically values between 1 and 16 mV/S are used.

6. Use the arrow keys to enter the new value and press **Enter Menu**. Press SLP DWN and enter a new value, if required.

   Typically values between 1 and 16 mV/S are used.

7. To change the filter setting, press FILTER.

8. Use the arrow keys to select the desired filter setting and press **Enter Menu**.

9. Press **Exit** to close the box. Press **Enter Menu** to close the menu.

10. Press **Enter Menu**, DISPLAY, GC, GRAPH and REINT.

    The signal will be re-integrated using the new integration settings.

11. Press DISPLAY, GC, PEAK to see if the peaks have been integrated more accurately.

12. If you need to change the settings for the other two columns, repeat this procedure for each column.

13. When you have changed the settings for each column, enable all the columns required for your method.

Minimum Height

The minimum height is the minimum peak height that will be accepted as a sample peak. This factor allows the integrator to eliminate peaks due to noise.

1. Press **Enter Menu**, SETUP, CONFIG, COLUMN.

2. Select the column for which you want to alter the analysis time. Disable the other columns.

3. Press **Exit** to close the box. Press **Enter Menu** to close the menu.

4. Press **Enter Menu**, SETUP, CONFIG, METHOD, ∫METH, and HEIGHT.

5. Use the arrow keys to enter the new value and press **Enter Menu**.

6. Press **Enter Menu**, DISPLAY, GC, GRAPH, REINT.
   The signal will be re-integrated using the new integration settings.

7. Press DISPLAY, GC, PEAK to see if the unwanted peaks have been removed.

8. If you need to change the settings for the other two columns, repeat this procedure for each column.

9. When you have changed the settings for each column, enable all the columns required for your method.

Automatic Integration

The choice of initial up/down slope and filter can require some expertise. Voyager automates this procedure as the up/down slope, Minimum height, and Filter options are set automatically if automatic integration is enabled.

These parameters are calculated on the basis of signal noise sampling during the first five seconds of an analysis. During the first five seconds of an analysis, the signal is sampled by the integrator at a frequency of approximately 20 Hz. The integrator uses linear regression to determine the best line through these sample points. The sample scatter is then used to determine the minimum height. The slope of each group of five sample points is then calculated. The scatter of the slopes is used to determine the up and down slope sensitivities.

If you have made changes to the integration settings and cannot obtain the desired integration, then try using the automatic integration features.

1. Press **Enter Menu**, SETUP, CONFIG, COLUMN.

2. Select the column for which you want to alter the integration settings. Disable the other columns.

3. Press **Exit** to close the box. Press **Enter Menu** to close the menu.

4. Press **Enter Menu**, SETUP, CONFIG, METHOD, ∫METH, and AUTO.

5. Use the arrow keys to select on and press **Enter Menu**. Press **Exit** to close the box.

6. Press **Enter Menu**, DISPLAY, GC, GRAPH and REINT.
   The signal will be re-integrated using the new integration settings.

7. Press DISPLAY, GC, PEAK to see if the peaks have been integrated accurately.

8. If you need to change the settings for the other two columns, repeat this procedure for each column.

9. When you have changed the settings for each column, enable all the columns required for your method.

Integrator Delay

The integrator delay is used to delay the start of integration after the analysis begins. It is used to prevent integration of peaks which may appear as a result of pressure changes during sample injection, especially when large syringe injections are made. If you have more than 25 peaks in an analysis, integrator delay may be used to determine which 25 peaks will be identified. If you are interested in the peaks in the middle or at the end of the chromatogram, set the integrator delay so that the first peaks are not integrated.

1. Press **Enter Menu**, SETUP, CONFIG, COLUMN.

2. Select the column for which you want to alter the integration settings. Disable the other columns.

3. Press **Exit** to close the box. Press **Enter Menu** to close the menu.

4. Press **Enter Menu**, SETUP, CONFIG, METHOD, ∫METH, and DELAY.

5. Use the arrow keys to enter a delay time and press **Enter Menu**.

6. Press **Enter Menu**, DISPLAY, GC, GRAPH and REINT.

7. If you need to change the settings for the other two columns, repeat this procedure for each column.

8. When you have changed the settings for each column, enable all the columns required for your method.

TVOC Methods

The TVOC method will provide accurate response in the approximate range 10 to 150 ppm when you use nitrogen carrier and are calibrating using 100 ppm isobutylene.

Carrier Gas and Injection Time

The easiest way to adjust TVOC sensitivity is to change the injection time. However this will also effect the range. The useful dynamic range is limited with nitrogen by the presence of a negative dip in the baseline caused by air in the sample. This negative peak is approximately 60 mV in height and it co-elutes with the VOC peak. Any peak which is to be accurately integrated must be greater than 100 mV in height. You can determine the peak height from the graph view. Voyager cannot quantitate a peak greater than 2500 mV in height.

The PID response is non-linear and this is seen as a disproportionate amount of signal at higher concentrations. When these factors are taken into account the useful dynamic range is about 15:1. The exact useful range will depend on the compound being analyzed. If the injection time is adjusted to give a 100 mV peak for 1 ppm benzene the working concentration range will be approximately 1 to 15 ppm. If the injection time is adjusted to give a 100 mV peak for 10 ppm benzene the working concentration range will be approximately 10 to 150ppm.

Voyager's sensitivity with nitrogen carrier gas is approximately 400 mV/ppm of benzene so the lower detection limit could be sub-ppm benzene if, for instance the injection time is set to 6 seconds.

The negative baseline dip also makes the TVOC less linear than the GC because the TVOC peak must first fill the air dip before a positive peak is obtained. This amounts to a sample loss which has the greatest effect on quantitation accuracy at low concentrations.

The ranges listed in the table below are approximate and are based on isobutylene samples.

Injection Time (s)	Approximate Range (ppm)
0.5	10 to 150
3	1 to 15
6	0.5 to 7.5

With air carrier gas, the TVOC can be used to make accurate measurements below 0.1 ppm since there is no negative baseline dip. The detector response will also be more linear over the concentration range. The sensitivity (peak height/ppm) is reduced to approximately 1/3 of that obtained with nitrogen carrier gas, but the absence of the negative baseline dip offsets the loss in sensitivity.

The ranges listed in the table below are approximate and are based on isobutylene samples.

Injection Time (s)	Approximate Range (ppm)
0.5	3 to 300
3	0.3 to 50
6	0.1 to 25

Effects of Other Parameters

Backflush does not have any effect in TVOC mode when loop injection is selected. When you are performing syringe injections, backflushing can reduce peak tailing caused by the injection port. Backflushing of the injection port begins at the specified backflush time.

The TVOC pressure setting will be the same as the last GC column method. When you switch between TVOC and GC modes there is no wait time while the pressure stabilizes at a new value.

You can operate the TVOC mode at 14 psi. This will increase sensitivity and reduce the TVOC analysis time allowing faster TVOC cycling. When you switch back to the GC method, the pressure will change to that specified by the GC method. You may have to wait a few minutes while Voyager adjusts the pressure and stabilizes the flow rates.

The default analysis time is 40 seconds. This is suitable for pressure settings between 8 and 14 psi. At 14 psi the TVOC peak elutes quickly and the analysis time could be reduced if faster cycling is required.

Calibration 6

Introduction

Gas chromatography is a comparative method; therefore, an unknown sample must be compared to a known standard in order for the sample components to be identified and quantified.

If Voyager will be used to analyze air samples then a pressurized supply of commercially prepared and analyzed calibration gas must be obtained for use with Voyager. This calibration gas can be used to fill gas bags or it can be connected directly to the Sample In port.

Voyager may also be used to analyze water samples. It is not designed to accept liquid injections, so water samples are analyzed using the headspace above samples. You should obtain commercially prepared standards. Contact the PerkinElmer Photovac Technical Support for more information on preparing aqueous standards.

CAUTION *Do not inject liquid samples into Voyager. You will damage the instrument*

You must calibrate using the same technique as your sample. If you are using automatic loop injection for sampling, calibrate using loop injection. If you are using syringe injection for sampling, calibrate using syringe injection.

Voyager should be calibrated at the start of each day of operation, and after each eight hours of operation. If the Method is changed, then calibration is required. Calibration is also required after most maintenance is performed.

Voyager should be operated within the temperature range of 5 °C to 40 °C (40 to 105 °F). If the instrument is exposed to a large temperature change, such as that encountered when going outside from an air conditioned lab in the summer, then allow Voyager to warm up for 20 to 30 minutes after being turned on.

When ambient conditions fall outside recommended specifications, Voyager should be in a controlled environment, i.e. in a vehicle with the heating or air conditioning running or indoors. Bring the sample to Voyager in gas bags, glass vessels or syringes.

Refer to the user notes supplied with your assay for a complete list of compounds that can be separated and identified. Compounds can be separated on one or more of the three columns. The information in the user notes will help you determine which columns you must use to obtain the best separation and provide specific details on calibration for your application.

The following procedures for calibration describe the calibration using the instrument alone. To facilitate calibration use SiteChart. If you cannot carry a PC into the field, perform a calibration before beginning field work and check the calibration once you reach your site.

The assay that is supplied with your instrument will allow you to perform a set of analyses that will separate and identify some or of all the library compounds. If you do not need to detect all the compounds contained in the library, you can edit the library. Refer to the user notes supplied with your assay for complete details.

NOTE: *You must make changes to the assay in the SiteChart software. If you create your custom assay on the instrument you cannot send it to the PC to be saved.*

Library

After each analysis, Voyager compares detected peaks against those in the library. It identifies those that match library compounds and then quantifies the identified peaks using the sensitivity from the library. Peaks are identified by comparing the retention time of the detected peak to the retention times stored in the library, or it identifies the peak as the largest peak within a retention time window.

Voyager calculates a sensitivity value for each compound when it is stored in the library. The sensitivity is the ratio of the measured response (peak area) to the actual concentration of the compound. Each time a calibration is performed the retention time and sensitivity values of each compound are updated in the library.

Each assay includes a library of compounds. The compounds and all associated calibration information have been provided as part of the assay. You may run the assay as it has been programmed for you, or you may customize the assay for your particular application.

If you have more than one assay or if you have created your own assay, a calibration must be performed to update the library information each time a different assay library is loaded for use.

If Voyager will be set up for loop injection, compounds must be stored by loop injection and then calibrations must be performed using loop injection techniques. Samples that are injected manually by syringe must be stored by syringe and then calibration must be performed by syringe injection. If both loop and syringe injection techniques are used, create a library for each.

NOTE: *Do not use a library created by loop injection interchangeably with one created by syringe injection.*

Selecting and Calibrating Compounds

Each compound you select will have pre-programmed analysis information stored in the library. If you have selected compounds that are all run on the same column then you need to run one analysis to calibrate your instrument.

If you selected compounds that must be separated on two columns, then you will need to perform two runs in order to calibrate your instrument. During calibration, you will select one column at time. Once the first column has been calibrated you will select and calibrate the second column. When calibration is complete you can enable both columns. When you are performing a sample analysis, you will need to perform two runs, one on each column, in order to complete your analysis.

If your selected compounds require all three columns for separation, you will need to complete three runs to calibrate the instrument. As with two columns, each column will be calibrated separately. When calibration is complete you can enable all three columns. When you are performing a sample analysis, you will need to perform three runs, one on each column, in order to complete your analysis.

During calibration, Voyager will look for all compounds listed in the library. You must obtain calibration gas containing all the compounds listed in the library. If you are using more than one column/detector pair, you must obtain calibration gas for each one.

NOTE: *To obtain the most accurate identification and quantitation of the compounds, ensure all compounds listed in the library are contained in the calibration gas.*

Calibration Gas

- Calibration gas containing all of the compounds of interest. The compounds and the concentration of the calibration gas will depend on your application. When ordering calibration gas, specify each compound and concentration. Specify a 5% blend tolerance, and a 2% analytical tolerance.

  Standards must be made up in hydrocarbon free air. Balance air should not have more than 0.1 ppm total hydrocarbons (THC). If your standards are unstable in air or if you are using nitrogen as carrier gas you may obtain your calibration standards made up in nitrogen. Balance nitrogen should not have more than 0.1 ppm total hydrocarbons (THC).

  When selecting calibration gas, keep in mind the upper and lower limits of the assay. Order each compound at a concentration that is close to the value of interest.

NOTE: *Since your samples will all be in air, it is not necessary to obtain standards in nitrogen if you are using nitrogen carrier gas.*

- Calibration gas regulator, with 1/4" compression fitting outlet. Use only the specified regulator for calibration gas. The regulator must be able to deliver up to 14 psig and 300 ml/min. Confirm regulator type and material with your specialty gas supplier. Assay 5, for example, contains highly corrosive compounds. You must obtain a high purity regulator for this calibration gas.

  Obtain a regulator with the appropriate inlet fitting for your calibration tank. Contact your specialty gas supplier for details.

  Check with your specialty gas supplier for any special accessories required for your regulator. Tighten the regulator onto the tank with a wrench. Do not over-tighten.

NOTE: *Do not force the connection. Do not use Teflon tape with CGA fittings. In general, these fittings are designed for metal to metal sealing.*

NOTE: *Do not use adapters to connect one CGA fitting to another type of CGA fitting. If the regulator does not match the outlet on your calibration tank, contact your specialty gas supplier.*

- Gas bags can be filled and used to calibrate the instrument. The gas bag and gas bag adapter are included in the Calibration Kits (MX380310 or MX380337). Complete details of calibrations are covered in *Calibration* starting on page 223.

Syringe Injection

For syringe injection of headspace samples, the following items are required:

- Gas syringe
- Septum capped vials.
- Septa

These items are included in the Assay 1 Calibration Kit (MX380310).

Connecting Calibration Gas

WARNING

Observe proper handling procedure for all compressed gases.

1. Connect a regulator to the tank of calibration gas.

   If more than one tank of calibration gas is required, connect a regulator to each tank.

NOTE: *Do not use regulators interchangeably as this will lead to contamination and erroneous calibration results. Refer to the user notes supplied with your assay to determine what type of calibration gas you require.*

2. Using a calibration flow adapter (MX380328), connect the regulator to the inlet of the flow adapter.

   You cannot connect a supply of pressurized calibration gas directly to the sample in port. The excess gas must be vented to atmosphere.

   The adapter is supplied with a 1/4”parallel compression fitting. If this does not fit your regulator you can remove the parallel to NPT adapter and use the 1/8” NPT port. You must put new Teflon tape on the male NPT thread in order to obtain a leak tight seal.

   You may need to use an additional length of stainless steel tubing between the regulator and the flow adapter to ensure the flow meter is perpendicular to the floor. If the flow meter is not upright, you may get erroneous flow rates.

3. Connect the tubing from the flow adapter to the adapter union (1/4” to 1/8”), as shown in Figure 9.

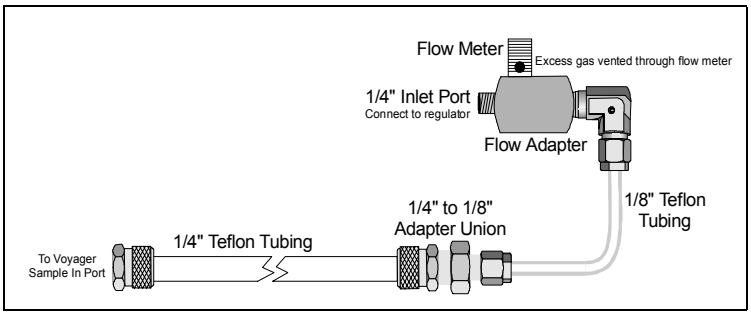


Figure 9 Connecting the Calibration Flow Adapter

4. A length of 1/4 "Teflon tubing with the 1/4" fittings is supplied with the flow adapter, connect one end of the tube to the 1/8" to 1/4" adapter union and connect the other end to the sample in port on Voyager.

NOTE: *If you will be using the extended probe or the long probe for sampling, ensure it is connected to the sample in port during calibration. Connect the probe directly to the 1/8" to 1/4" adapter union instead of using the adapter tubing. You must also select the probe option on Voyager to allow for a longer pump time, by pressing* **Enter Menu***, then SETUP, MODE, INJECT, and PROBE and select the desired probe from the box using the arrow keys. The pump time will be adjusted automatically.*

5. Open the tank of calibration gas, opening the regulator valve slowly.

   The float on the flow adapter must be floating. The float should not be in the red zone and it must not be seated at the bottom of the tube. When the pump comes on the float must still be floating, this will ensure calibration gas is being properly delivered.

6. If you are not using the flow adapter, set the regulator to deliver 300 mL/min.

   Use a stainless steel tee to vent the excess calibration gas.

NOTE: *If any compounds contained in the calibration gas exceed the TLV concentrations, perform the analyses in a well ventilated area or use a gas bag.*

NOTE: *Allow the calibration gas to flush all the tubing before beginning an analysis. After the injection has been made, close the tank of calibration gas and then close the regulator.*

Preparing a Gas Bag Sample

WARNING

Observe proper handling techniques for all gases.

NOTE: *Connect the regulator to the calibration gas cylinder. You must obtain calibration gas and a high purity regulator. Obtain a regulator matching the fitting on your tank of calibration gas. The regulator must have a 1/4" compression fitting at the outlet in order to use the calibration kit.*

1. Tighten the regulator onto the tank with a wrench.
   Do not over-tighten.

2. Attach the knurled nut on the gas bag adapter to the regulator, as shown in Figure 10.
   Finger-tighten the fitting.

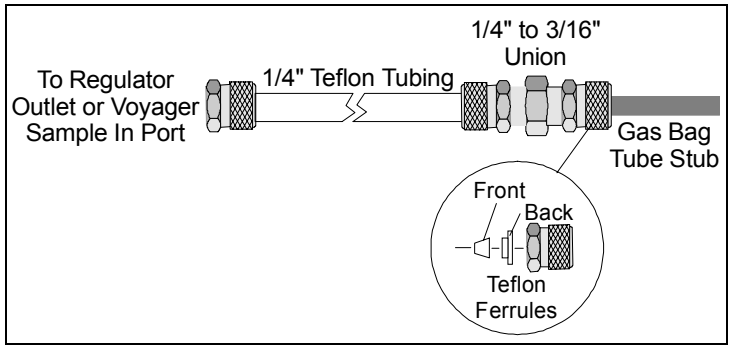


Figure 10 Gas Bag Adapter

3. Loosen the knurled nut on the reducing union of the gas bag adapter.

NOTE: *Do not remove the nut from the union as the Teflon ferrules contained inside the nut may be lost. See Figure 10.*

4. Insert the tube stub from the gas bag into the knurled nut and tighten the knurled nut and ensure the tube stub is secure.

   If the gas bag is not secure, ensure you have inserted the tube stub far enough into the knurled nut.

   Do not over tighten the fitting.

NOTE: *Over-tightening the Teflon ferrules will result in damage to the ferrules!*

5. The union should be connected to the gas bag adapter, if it is not, then tighten the nut on the adapter tube to the union.

6. Open the gas bag valve by turning the knurled plastic knob counterclockwise to loosen it, then use the knurled collar on the valve tube to gently push the valve tube toward the bag.

NOTE: *Do not use the same gas bag or gas bag adapter for other compounds or calibration mixes. You will contaminate the bag, the adapter and possibly the instrument.*

7. Turn the regulator knob counterclockwise about half a turn to start the flow of gas and fill the gas bag about half full and then close the regulator.

8. Disconnect the gas bag from the gas bag adapter and empty the bag.

9. Flush the bag a few times with the calibration gas and then fill it.

10. Close the gas bag valve, gently pull the valve tube up, then turn the knurled plastic knob clockwise to tighten it against the valve tube.

11. Remove the knurled nut on the adapter tube from the regulator.

Using the Gas Bag

Figure 11 shows details of using the gas bag.

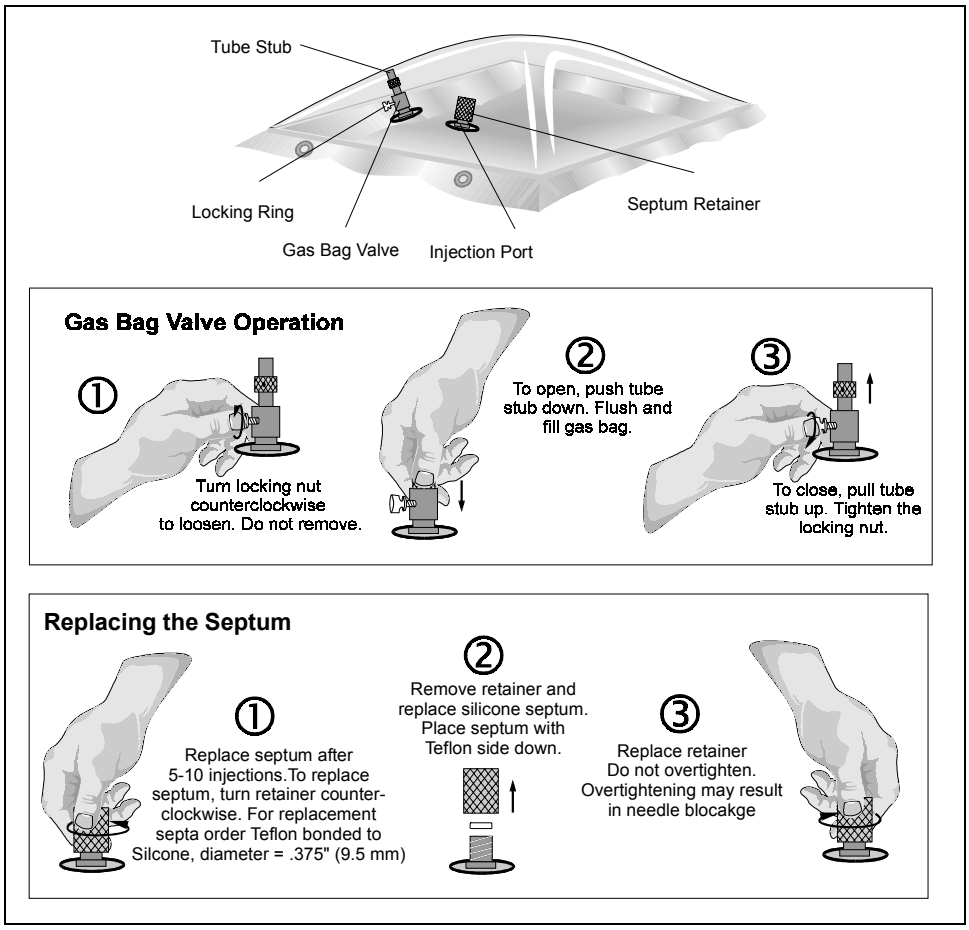

Tube Stub
Locking Ring
Gas Bag Valve
Injection Port
Septum Retainer
Gas Bag Valve Operation
①
Turn locking nut counterclockwise to loosen. Do not remove.
②
To open, push tube stub down. Flush and fill gas bag.
③
To close, pull tube stub up. Tighten the locking nut.
Replacing the Septum
①
Replace septum after 5-10 injections.To replace septum, turn retainer counter-clockwise. For replacement septa order Teflon bonded to Silcone, diameter = .375" (9.5 mm)
②
Remove retainer and replace silicone septum. Place septum with Teflon side down.
③
Replace retainer Do not overtighten. Overtightening may result in needle blocakge

Figure 11 Using the Gas Bag

Calibration Procedure

Single Detector

1. Select a column.

2. Press **Enter Menu**, then SETUP, CONFIG, and COLUMN.

3. Use the arrow keys to move through the list and press **Enter Menu** to select PID Column A, B or C or ECD Column A, B or C.

   Ensure only one column/detector combination is selected.

   There are two libraries for each column. The PID library or the ECD library is automatically selected when you choose a column/detector combination.

4. Press **Exit** to close the box.

5. Press **Enter Menu**, then LIBRARY, and LIST.

6. Press the left/right arrow to select the library that matches your selected column.

   The status line at the top of the screen will tell you which library you are using.

   Compounds with a check mark are currently selected for calibration.

7. Use the up/down arrows to move through the list of compounds, and then to enable or disable a compound, move to the compound name and press EDIT and CALCMPD.

   This will toggle the compound on and off. If the compound is not selected remove it from the library. If the compound is not selected, its response and retention time will be updated ratio-metrically.

8. Press EDIT and CALCONC to enter the concentration for the compound.

   Use the arrow keys to enter the concentration of the compound in your calibration gas. If the concentration displayed in the Cal column is correct, move to the next compound.

   Move through the list and check that you have enabled all the compounds and that you have entered the correct calibration concentration. Remove any unwanted compounds from the library.

NOTE: *Compounds not contained in the calibration gas must be removed from the library, see* Removing Library Compounds *on page 249.*

9. Ensure you are viewing the correct detector output. To change the view, press DISPLAY, GC, and DET, and when prompted to change views, press **Enter Menu**.

10. Connect a supply of calibration gas, as outlined , or prepare a syringe sample. Your calibration gas must contain all the compounds that are enabled in the selected library.

11. Press **Start Stop** to begin an analysis.

12. Press DISPLAY, GC, and CMPD to view the compound list.

13. When the analysis is complete, review the compound list and ensure all your calibration compounds are present.

14. Press **Enter Menu**, then LIBRARY, and CAL.

15. When prompted to calibrate using the last analysis, select YES.

    If Voyager can match all the compounds in the last analysis with compounds you have selected for calibration then your library information will be updated accordingly.

NOTE: *If a calibration fault is displayed see* Calibration Fault *starting on page 283 for information about correcting the fault*

NOTE: *If you need to calibrate a second, or third, column, select the next column and disable the previous one. Press* **Enter Menu***, then* SETUP*,* CONFIG*, and* COLUMN*. Use the arrow keys to move through the list and press* **Enter Menu** *to select PID Column A, B or C or ECD Column A, B or C, ensuring only one column/detector combination is selected. Then calibrate the column as above. If you are using more than one column, enable the columns once you calibrated each one of them.*

Dual Detectors

1. Select a column by pressing **Enter Menu**, then SETUP, CONFIG, and COLUMN.

2. Use the arrow keys to move through the list and press **Enter Menu** to select PID Column A, B or C and ECD Column A, B or C.

   Ensure only one column and both detectors are selected. If you are calibrating Column B, select PID Column B and ECD Column B.

3. Press **Exit** to close the box.

   Both the PID library and the ECD library will be selected. Look at the status line to determine which detector you are viewing on the screen. If you are not viewing the PID library, switch to the PID by pressing DISPLAY, GC, and DET, then when prompted to change views press **Enter Menu**.

4. To select the PID compounds for your application, press **Enter Menu**, then LIBRARY, and LIST, and press the left/right arrow to select the library that matches your selected column.

   The status line at the top of the screen will tell you which library you are using.

   Compounds with a check mark are currently selected for calibration.

5. Use the up/down arrows to move through the list of compounds. To enable or disable a compound, move to the compound name and press EDIT and CALCMPD.

   This will toggle the compound on and off. If the compound is not selected remove it from the library.

6. Press EDIT and CALCONC to enter the concentration for each enabled compound.

   Use the arrow keys to enter the concentration.

   If the concentration displayed in the Cal column is correct, move to the next compound.

   Move through the list and check that you have enabled all the compounds contained in the calibration gas and have entered the correct calibration concentration.

NOTE: *Compounds not contained in the calibration gas must be removed from the library, see* Removing Library Compounds *on page 249.*

7. To switch to the ECD view, press DISPLAY, GC, and DET, and when prompted to change views press **Enter Menu**.

8. To select the ECD compounds for your application, press **Enter Menu**, then LIBRARY and LIST, and press the left/right arrow to select the library that matches your selected column.

   The status line at the top of the screen will tell you which library you are using. Compounds with a check mark are currently selected for calibration. If the compound is not selected, remove it from the library.

9. Press EDIT and CALCONC to enter the concentration for the compound.

   If the concentration displayed in the Cal column is correct, move to the next compound.

   Move through the list and check that you have enabled all the compounds of interest and have entered the correct calibration concentration and again remove any unwanted compounds from the library.

10. Connect a supply of calibration gas, as discussed on page 231, or prepare a syringe sample.

NOTE: *Your calibration gas must both PID and ECD calibration compounds. If your calibration gas contains only the PID compounds, then you must calibrate each detector separately.*

11. Press **Start Stop** to begin an analysis.

12. Press DISPLAY, GC, and CMPD to view the compound list.

    Since you are viewing the ECD output, the compound list will show the ECD compounds.

13. When the analysis is complete, review the compound list and ensure all of your ECD compounds are present.

14. Press **Enter Menu**, then LIBRARY and CAL, and when prompted to calibrate using the last analysis, select YES.

    If Voyager can match all the compounds in the last analysis with compounds you have selected for calibration then your ECD library information will be updated accordingly.

15. Switch to the PID view by pressing DISPLAY, GC, and DET.

16. Review the compound list and ensure all of your PID compounds are present.

17. Press **Enter Menu**, then LIBRARY and CAL, and when prompted to calibrate using the last analysis, select YES.

    If Voyager can match all the compounds in the last analysis with compounds you have selected for calibration then your PID library information will be updated accordingly.

NOTE: *If a calibration fault is displayed see* Calibration Fault *starting on page 283 for information about correcting the fault*

NOTE: *If you need to calibrate a second, or third, column, select the next column and disable the previous one. Ensure only one column and both detectors are selected. If you are calibrating Column B, select PID Column C and ECD Column C. Calibrate the column as above, and if you are using more than one column, enable the columns once you have calibrated each one of them.*

Multiple Point Calibration Curve

NOTE: *Changes made to the library using Voyager directly, cannot be saved to disk. The changes will be lost when a new method is loaded.*

Multiple point calibration may be used to improve the accuracy of Voyager's response over a wide concentration range.

Within a library, each compound may be stored at up to 5 different concentration points. The first point is always (0, 0), and you can store 4 additional concentration points. You can also select one of four calibration curves; line segment, linear fit, quadratic fit or cubic fit.

When you perform a calibration, the calibration curve is updated based on the single concentration point contained in the calibration gas.

Line Segment Calibration Curve

If one concentration point is stored, Voyager draws a line from this (0, 0) to the single point and uses the line as the calibration curve. If the compound is stored at a second, higher concentration, sample concentrations are calculated using the first sensitivity when the concentration is below the lower concentration. For concentrations above the lower value, Voyager uses a sensitivity value calculated from the slope of the line connecting the two concentration response points.

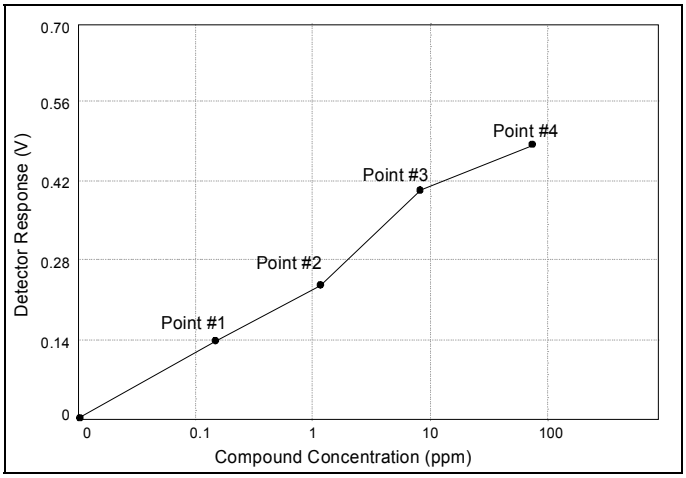


Figure 12 Line Segment Calibration Curve

If a third, higher concentration is stored, then the concentrations above the second value are measured using a sensitivity value calculated from the slope of the line connecting the second and third concentration response points. You can store up to five concentration points.

Linear Calibration Curve

If you select linear calibration, Voyager will draw the best line through all the points. It will use a linear least squares fit to determine the slope of the line. The line will always start at (0, 0). If you have stored only one point you will have a line segment curve. If you have stored 2 or more points, Voyager will use the least squares fit.

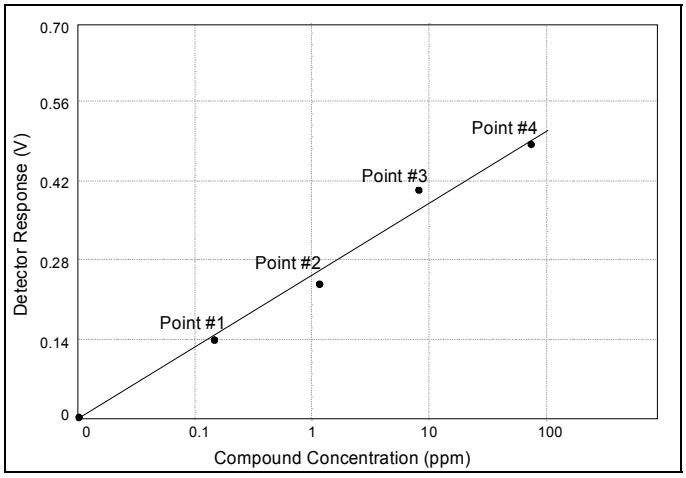


Figure 13 Linear Calibration Curve

Quadratic and Cubic Calibration Curve

A quadratic calibration curve fits a quadratic function to the points you have stored. In order to use the quadratic calibration curve, you must store at least 2 or more points. The curve will always start at (0, 0) and go through all the points you have stored. In order to obtain the most accurate results you should store a point that is at the top end of the concentration range at which you are looking. If you are interested in the range 10 to 100 ppm, store a point at 100 ppm. Data past this point will be extrapolated based on a tangent through the last stored point.

A cubic calibration curve fits a third order function to the points you have stored. You must store at least three points in order to use a cubic calibration curve. As with the quadratic curve, you should store a point at the top end of your concentration range.

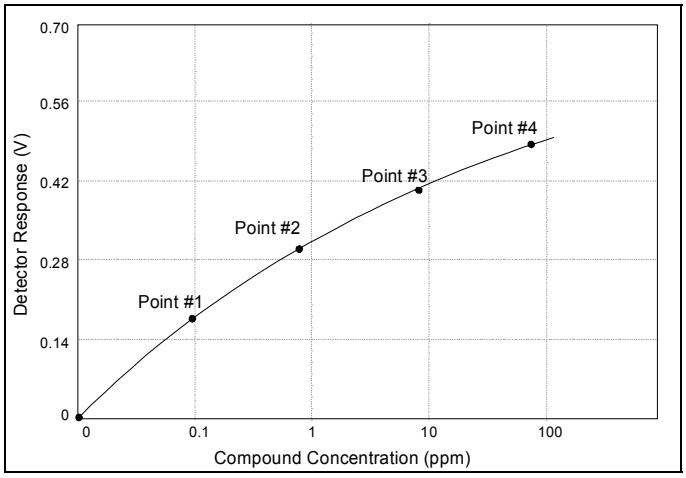


Figure 14 Quadratic Calibration Curve

Storing Multiple Points

As good analytical practice, standards for multiple point calibrations should be run and stored in the library in order of increasing concentration.

When a calibration is performed, only one point will be used to update the calibration curve that you have created. All of the points on the curve are updated based on the response ratio from the single point, contained in the calibration gas. Ideally, you will choose a point in the middle of the calibration curve as the concentration to be included in the calibration gas.

For high accuracy applications, you may want to do multiple point calibration on a daily basis.

1. Select the correct column for your compounds.
   If your compounds of interest must be run on more than one column, you must store information for one column at a time.

2. Connect your sample and press **Start Stop** to begin an analysis.

3. When the analysis is complete you must store the new point.

   If you are storing a number of compounds then you may want to print the analysis for ease of reference. Use a PC and the SiteChart software to print the analysis.

4. Press **Enter Menu**, then LIBRARY, LIST, EDIT, and STORE, and enter the peak number to be stored in the box that opens, then press **Enter Menu** to confirm the peak number.

   Voyager will display the matching compound name from the current library.

5. Press **Enter Menu** to confirm.

NOTE: *If the identified compound is not the compound you are trying to store, then you are using the wrong library. Press* **Enter Menu***, then* LIBRARY *and use the left/right arrow key to select the correct library.*

6. Use the up/down arrow keys to select the point you want to add and press **Exit**.

7. Use the arrow keys to enter the correct concentration and press **Enter Menu**.

8. Use the arrow keys to enter the window size.

   You may want to decrease the window for higher concentrations.

9. Press **Enter Menu** to complete the process.

   You have now stored the compound at two concentrations.

10. Repeat these steps for all compounds you want to store and for all concentration points.

11. Connect a supply of calibration gas and press **Start Stop** to begin an analysis.

12. When the analysis is complete, review the compound list and ensure all your compounds are present.

13. Press **Enter Menu**, then LIBRARY and CAL, and when prompted to calibrate using the last analysis, select YES.

    If Voyager can match all the compounds in the last analysis with compounds you have selected for calibration then your Library information will be updated accordingly and the instrument will be ready for operation.

NOTE: *If a calibration fault is displayed see* Calibration Fault *starting on page 283 for information about correcting the fault.*

TVOC Calibration

The TVOC mode must be calibrated in order to display concentration in ppm units equivalent to the calibration gas. Calibration gas, containing a known concentration of a photoionizable gas or vapor, is used to set the sensitivity.

A standard of isobutylene at a known concentration is recommended for setting the TVOC sensitivity. If Voyager is calibrated with isobutylene, it displays concentrations in units equivalent to ppm of isobutylene. If isobutylene were the only photoionizable compound in the sample, then Voyager would display its concentration directly.

Voyager responds more or less readily to other compounds than it does to isobutylene. Because it has a medium sensitivity to isobutylene, this gas has been chosen as a reliable means of reporting an average concentration of total photoionizable volatile organic compounds.

For special applications, gases other than isobutylene can be used to calibrate Voyager. Contact PerkinElmer Photovac Technical Support for more information.

- If you are using the long probe or the extended probe for sampling, then ensure the probe is connected to Voyager and press **Enter Menu**, then SETUP, MODE, INJECT and PROBE and select the probe you are using.

  Voyager will then adjust its pump time so that the pump will draw an accurate sample.

NOTE: *Ensure the sample probe is free of any contamination as this will affect the calibration.*

1. Press **Enter Menu**, then DISPLAY, VOC and REPORT to ensure Voyager is in TVOC mode.

2. Press **Enter Menu**, then LIBRARY and ALARM and enter an alarm level.

3. Press SPAN and enter the span gas concentration.

4. Press **Enter Menu** to clear the menu.

5. Connect a supply of calibration gas to the sample in port as outlined in *Connecting Calibration Gas* on page 231.

   Use a clean regulator for the TVOC calibration gas.

6. Ensure the calibration gas cylinder is upright and open the regulator by turning the valve counterclockwise.

   Open the regulator until the float is 1/8" from its rest position.

7. Press **Start Stop** to begin a run.

8. When the run is complete, press **Enter Menu**, then LIBRARY and CAL and when prompted to calibrate using the last analysis, press YES.

   Voyager sets its sensitivity.

   When the display reverts to the default display, TVOC mode is calibrated and ready for use.

9. Ensure the correct concentration is displayed and then remove the adapter tubing from the sample in port and from the regulator.

Removing Library Compounds

Compounds that are not required as part of your application should be removed from the library. This may speed analysis time and will reduce the possibility of misidentification due to co-elution. Refer to the user notes supplied with your assay for details.

NOTE: *You must make modifications to the assay in the SiteChart software. If you create your custom assay on the instrument you cannot save it.*

1. Open a copy of the assay.
   Do not modify your original assay.

2. To remove compounds from the library, press **Enter Menu**, then LIBRARY, LIST, EDIT, and STORE.

3. When prompted for a Peak No., enter 0 to erase the compound from the library.

4. Make all the changes required and then save it as your custom application.

Maintenance and Troubleshooting 7

Maintenance Schedule

WARNING

Do not perform any maintenance procedures on Voyager in hazardous locations.

Voyager requires regular maintenance to keep it operating efficiently. Replacement of some items will vary with usage, the following table shows the suggested maintenance periods:

Item/Operation	Frequency
Replace injection port septum	Every 10 injections
Replace inlet filter	Once a week
Clean UV lamp window	Once a week or as required
Update assay	As required
Wipe Test the ECD (Contact your local authority for regulations.)	Every 6 months (USA), every year (Canada)
Replace UV lamp	Once a year or as required
Replace calibration gas (commercial cylinder)	Once a year or as required
Purge internal carrier gas cylinder	As required
Condition column	As required
Charge battery pack	As required

WARNING

You are not authorized to clean the ECD. Do not put any cleaning agents through the ECD.

Replacing the Sample Inlet Filter

WARNING

Do not remove or replace the inlet filter in hazardous locations.

Voyager is equipped with a combined dust and water filter to reduce detector contamination. As the filter collects dust, Voyager's inlet flow rate and sensitivity decrease. The filter will not allow water to pass through, but the filter will not stop all solvents.

Do not aspirate liquid samples with Voyager.

CAUTION

Replace the filter on a weekly basis, or more frequently if Voyager is used in a dusty or wet environment. You must replace the filter if Voyager has been exposed to liquid water. If you are sampling hot gases or vapors, condensation in the sample line may also affect the filter. The pump will sound labored when the filter requires replacement.

1. Turn the instrument off.
2. If you are using a three meter sample line or an extension probe, remove the probe from the sample in port.
3. Unscrew the filter housing from the inlet housing.
   Be careful not to lose the o-ring seal.

NOTE: *Each filter is protected by a piece of blue plastic. Remove the plastic before installing the filter in Voyager.*

4. Remove the Teflon/Polypropylene filter and install the new filter (MX396020 or MX396015).

5. Place the filter so that the Teflon side is facing down in the filter housing and the mesh side is facing Voyager.

   Handle the filter disk only by the edges. The mesh may be damaged or contaminated by excessive handling. Use forceps or tweezers if possible.

6. Replace the filter housing.

NOTE: *Calibrate all GC and TVOC modes before returning to normal operation.*

NEVER operate Voyager without an inlet filter.

CAUTION

Maintenance of the UV Lamp

During normal operation of the photoionization detector, the lamp window will become coated with UV-absorbing material from the sample stream. This reduces the lamp's effective light output and results in a substantial drop in the detector response. Removal of the lamp and proper cleaning of the lamp window may restore the detector sensitivity. As a guide, clean the GC lamp window every week.

If the lamp fault appears, the UV lamp has failed. Open the Status box in the GC mode and check the Lamp Status. If a Timeout Fail or Intensity Fail is displayed then the UV lamp must be replaced.

Removing the UV Lamp

WARNING

Do not remove the UV lamp in hazardous locations.

1. Ensure the instrument is turned off.

WARNING

You must turn the instrument off before removing the lamp cover.

2. Remove the lamp access cover using the hex driver supplied with the tool kit.
3. Use the multi-tool provided to remove the lamp housing cover.
4. Tilt Voyager slightly and remove the UV lamp.

WARNING

The lamp may be hot.

CAUTION

Do not touch the detector cell. Any dust or dirt in the detector cell can be blown out with a gentle jet of carrier gas.

Replacing the UV Lamp or Installing a New One

1. Place the new o-ring on the new lamp.
2. Without touching the lamp window, place the new lamp into Voyager lampholder, window first.

NOTE: *Do not insert any object, other than the UV lamp, into the lampholder.*

3. Replace the lamp housing cover and then replace the access cover.
4. Calibrate the GC and TVOC and then continue normal operation.

Cleaning the UV Lamp Window

Since some UV inhibiting deposits are invisible to the eye, regular cleaning of the lamp window is strongly recommended. It is best to clean the lamp frequently, once a month or more depending on the detector usage, to prevent a heavy build-up of deposits that may be difficult to remove.

The UV lamp cleaning kit (MX380336) includes aluminum oxide (3.0 micron powder) and cotton swabs. Additionally, you will require lint free tissues and approximately 10 mL of methanol. When ordering methanol, specify Spectroscopic Grade.

WARNING

Never touch the UV lamp with your fingers.

1. Remove the lamp as outlined above.
2. Allow the lamp to cool to room temperature.
   This will avoid thermal shock, which could crack the window.
3. Remove the o-ring.
   Do not allow the o-ring to come in contact with methanol, as methanol will degrade the o-ring material and may result in leaks in your system.
4. Dampen a cotton swab in methanol and dab it into the cleaning compound supplied, allowing a small amount of the cleaning compound to adhere to the cotton tip.
5. Using small a circular motion, rub the cleaning compound onto the lamp window for approximately one minute.
   Do not exert excessive force onto the window, since the window can be permanently damaged by misuse.
6. Dampen a new cotton swab with methanol and remove any trace amounts of the cleaning compound from the lamp window.
7. Wipe the window and the lamp with a dry, lint free tissue to remove any trace amounts of the cleaning compound and methanol.
   All traces of cleaning compound must be removed.

8. Ensuring your hands are clean and dry, replace the o-ring.
   Again, do not allow the o-ring to come in contact with methanol.

9. Without touching the lamp window, replace the lamp as outlined above.

Maintenance of the Injection Port

Replacing the Injection Port Septum

A worn out septum causes leakage, which will result in poor reproducibility and an unstable baseline. When an injection is made, the baseline will suddenly drop below zero as the needle is pushed against the septum. This will also occur if the septum is improperly seated in the injection port.

A silicone septum with a Teflon face (MX380320) is recommended for use with Voyager. This type of septum will last for about 10 injections depending on the syringe needle.

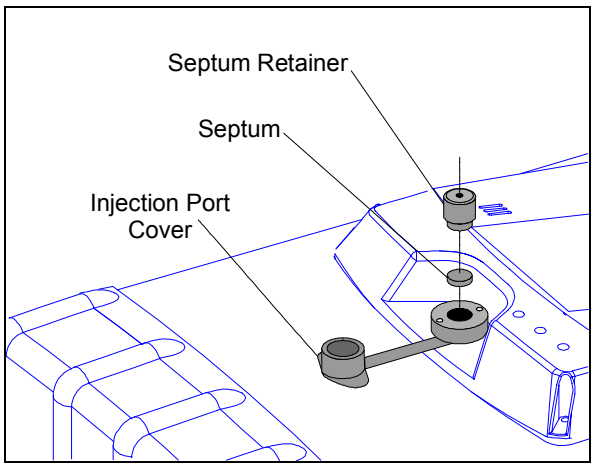


Figure 15 Replacing Septum

1. Move the instrument to an area where the ambient air contains no VOCs.
2. Unscrew the black septum retainer.
3. Use a syringe needle to withdraw the old septum.

4. Ensuring that you do not touch the new septum with your fingers, place the new septum, Teflon face down, in the injection port.

   Tweezers should be used.

NOTE: *Touching the septum with your fingers will lead to contamination of the system.*

5. Position the septum in the injection port with the syringe needle and then carefully screw the black retainer back in place.

   Finger-tighten the retainer.

NOTE: *The septum retainer must not be over tightened. This will cause unusual resistance to needle penetration and may result in needle blockage.*

6. The retainer should be tightened so that the septum is seated against the lower half of the injection port assembly.

   Coring of the septum can be reduced by using sidebore syringe needles.

Cleaning the Injection Port Assembly

CAUTION	*Do not remove the injection port assembly. Removal opens Voyager's analytical engine to the environment.*

Flushing the Columns

NOTE: *To avoid system contamination, do not allow the internal carrier gas cylinder to empty completely.*

By definition, column packing or coating materials are very efficient adsorbers of chemicals. If a column is left without continuous gas flow, contaminants present in the air may enter through the ends of the column. These contaminants will accumulate and when the column is put back into service the resumed flow of carrier gas will carry a high concentration of contaminants into the detector. This will decrease as the column cleans, but levels may be sufficiently high, initially, to saturate the detector.

Saturation has occurred when the offset level is greater than 800 mV. At this point the signal level can no longer be set to 10% of full scale at the start of an analysis. Saturation can also occur if many high concentration samples are analyzed in succession.

Saturation can often be reduced or eliminated by allowing carrier gas to flush the column and detector for a few hours. Normally, columns that are not in use are flushed with a low flow of carrier gas. If possible, you can take the contaminated column out of service and use the remaining columns to run analyses. The contaminated column will eventually be flushed and be available for use. To speed up the flushing process, you may increase the carrier gas flow through the contaminated column. If you use this procedure, you will not be able to run analyses on the instrument while the columns are flushing.

Flushing a Single Column

1. Move the instrument to an area where the ambient air contains no VOCs.
2. If the instrument is auto-analyzing, disable that option.
3. Switch to supervisor mode by pressing **Enter Menu**, then SETUP and MODE, then use the arrow keys to select Super.
4. Press **Enter Menu** and **Exit**.

5. When the password is requested, enter 12344321 and press **Enter Menu.**
   You are now in supervisor mode.
   The password is factory set and cannot be changed.

6. Press SETUP, CONFIG, and COLUMN to select the column to be flushed.

7. Press SETUP, CONFIG, METHOD, and PRESS to increase the flow through the columns.
   Set the pressure to the maximum of 14 psig and allow the column to flush for a few hours until the offset level returns to 200-800 mV.

NOTE: *If the instrument is in user mode, you will not be able to increase the flow rate.*

8. Ensure the internal carrier gas tank is full or connect the instrument to an external tank of carrier gas as detailed in *Carrier Gas* starting on page 44.

Flushing all Three Columns

1. Move the instrument to an area where the ambient air contains no VOCs.

2. Connect a supply of carrier gas to the sample in port.

3. Use a clean gas bag filled with zero air or nitrogen, or if you are using a pressurized supply of gas, set the delivery pressure to no more than 14 psig.

4. If the instrument is auto-analyzing, disable the option.

5. Switch to supervisor mode by pressing **Enter Menu**, then SETUP and MODE, then use the arrow keys to select Super.

6. When the password is requested, enter 12344321 and press **Enter Menu.**
   You are now in supervisor mode.
   The password is factory set and cannot be changed.

7. Press SETUP, CONFIG, and COLUMN to select all the columns to be flushed.

8. Press SETUP, CONFIG, METHOD, and PRESS to increase the flow through the columns.

   Set the pressure to the maximum of 14 psig.

NOTE: *If the instrument is in user mode, you will not be able to increase the flow rate.*

9. Enable auto-analyzing.

   Voyager will cycle through the columns, injecting a sample of carrier gas onto each column.

   Continue cycling until the offset returns to a normal range of 200-800 mV.

10. Ensure the internal carrier gas tank is full or connect the instrument to an external tank of carrier gas as detailed in *Carrier Gas* starting on page 44.

Purging the Internal Carrier Gas Cylinder

NOTE: *To avoid instrument contamination, do not allow the cylinder to empty completely.*

If the internal cylinder has been empty for any period of time, it must be purged to eliminate the possibility of system contamination. If you change carrier gas, you must also flush and purge the internal tank with the new carrier gas.

WARNING

Do not purge the cylinder in hazardous locations.

1. Fill the internal cylinder with the carrier gas filling station as described in Filling the Internal Cylinder on page 44.
2. Loosen the purge valve to empty the cylinder.
   The purge valve is located below the carrier in port.
3. When the cylinder is empty, close the purge valve.
4. Fill the cylinder again.
5. Open the purge valve and empty the cylinder again.
6. Close the valve and fill the cylinder.
7. Run a sample of clean air to ensure no contamination has entered the system.

NOTE: *Once you have filled the reservoir with carrier gas, you must allow the instrument to purge for 3-4 hours, preferably overnight. This will flush the analytical engine with the new carrier gas.*

Maintenance of the ECD

WARNING

Do not open Voyager or remove the ECD. If the ECD must be removed from the instrument contact PerkinElmer Photovac Service.

WARNING

You are not authorized to clean the ECD. Do not put any cleaning agents through the ECD.

Purging the ECD

There are various indicators of GC contamination for an ECD.

- Increased baseline level and reduced range.
- Increased noise on the baseline.
- Negative dips following large positive peaks
- Reduced sensitivity.

If you are experiencing any of these problems, purge your ECD. If this does not correct the problem, then contact the PerkinElmer Photovac Service Department.

1. Move the instrument to an area where the ambient air contains no VOCs.
2. Switch to supervisor mode by pressing **Enter Menu**, then SETUP and MODE, then use the arrow keys to select Super.

3. Press **Enter Menu** and **Exit** and enter the password as 12344321 and press **Enter Menu**.

   You are now in supervisor mode.

NOTE: *If the instrument is in user mode, you will not be able to increase the temperature and pressure.*

4. Increase the flow through the columns by pressing SETUP, CONFIG, METHOD, and PRESS and set the pressure to the maximum of 14 psi.

5. Increase the temperature to 80 °C by pressing **Enter Menu**, then SETUP, CONFIG, METHOD, TEMP, and ECD and using the arrow keys to enter the new ECD temperature, then press **Enter Menu**.

6. Ensure the internal carrier gas tank is full or connect the instrument to an external tank of carrier gas.

   You must use nitrogen carrier gas for the ECD

7. Allow the ECD to purge for at least 8 hours.

8. Change the view from the PID to the ECD by pressing DISPLAY, GC, and DET, and when prompted to change views to the ECD, press **Enter Menu**.

9. Monitor the offset level as displayed on the status screen and wait until it has stabilized before attempting to use the instrument.

   An instrument that is cleaning out will show an unstable and dropping baseline. Typical offset is in the range 200-800 mV and anything over 800 mV indicates contamination.

Obtaining an ECD Wipe Test Sample

NOTE: *You must obtain a wipe test kit from an authorized laboratory or consulting firm, see* Wipe Test Agencies *on page 480 for a list of agencies in the U.S. In Canada you must use an agency, unless you have been authorized by the AECB to perform wipe tests, contact the AECB for more information, see page 479. When ordering a wipe test or a wipe test kit, specify that the sensitivity of the wipe test be 0.0001 microcurie.* Ni^{63} *is a beta emitter.*

WARNING

Until the results of the wipe test are known, use caution and suitable protection when handling equipment in contact with the ECD. Wear disposable plastic or rubber gloves when performing this test.

1. Turn the instrument off and allow the detector to cool to the touch.

2. Remove the ECD access cover, as shown in Figure 16, using the hex driver supplied with the tool kit for this purpose.

   Do not lose the three hex screws.

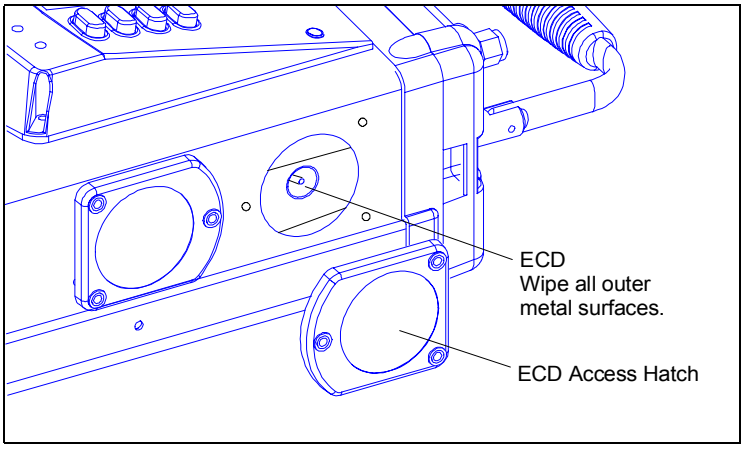


Figure 16 Access to ECD for Wipe Testing

3. Using the instructions included with the wipe-test kit, wipe the all the accessible metal surfaces of the detector with the cotton swab.

4. Wipe the vent fitting on the top panel of the Voyager, as shown in Figure 17.

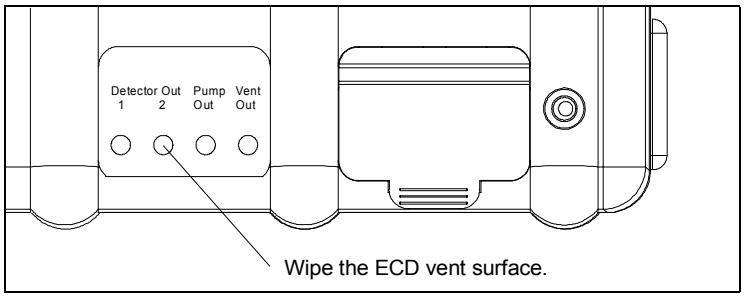


Figure 17 ECD Vent

5. Place the cotton swab in the container provided in the wipe-test kit and include a data sheet stating that the wipe test was performed on a PerkinElmer Photovac ECD, the serial number of the instrument and the date of the test.

6. Replace the ECD access hatch.

7. Return the envelope to the leak testing center specified in the leak test kit and request that a new wipe-test kit be sent with the test results.

WARNING

If the ECD does not pass the wipe test, contact PerkinElmer Photovac Service immediately.

Disposing of an ECD Cell

If it is necessary to dispose of Voyager, equipped with an ECD, or to have the ECD detector removed from Voyager, contact:

PerkinElmer Instruments
710 Bridgeport Avenue
Shelton, CT. 06484-4794

PerkinElmer Photovac can supply shipping and disposal instructions and current fees.

In addition, report the ECD cell disposal to the NRC:

Nuclear Material Safety and Safeguard
U.S. Nuclear Regulatory Commission
Washington, DC 20255

You may also need to report the cell disposal to your state and local agency. If you are in an Agreement State, you must report the cell disposal to the state agency, see *Agreement States* on page 475.

In Canada, you must report the proposed ECD cell disposal to the AECB before you dispose of the cell, see page 479.

Downloading Firmware to Voyager

Voyager has been designed so that you can easily download the newest version of firmware to the instrument. You do not need to open the instrument and remove the current EPROM, you simply connect Voyager to a PC and download the firmware to the EPROM.

In order to establish communication with Voyager and send data, the PC must be set up to emulate a terminal. In order to do this you will need a communications software package that will allow you to transfer data from the PC to Voyager. If you are using Microsoft Windows you do not need to purchase any separate software, Windows contains a communication program called Terminal Program or HyperTerminal depending on which version of Windows you are running.

You will use the communication or terminal emulation software package to set up the PC to send data at 9600 baud, no parity, 8 data bits and 1 stop bit. Refer to the manual, provided with your software, for specific details.

The instructions below will provide you with the most basic information for using Voyager with HyperTerminal. In order to use HyperTerminal, you must be familiar with Windows 95/98/NT and it must be installed and running on your PC. HyperTerminal is supplied with Windows 95/98/NT. Refer to the Microsoft Windows User's Guide for detailed instructions on installation and operation of Windows 95/98/NT and HyperTerminal. If you are using another software package, please refer to your software's user manual for specific details of operation.

WARNING

Voyager is not classified for use in hazardous locations with a PC.

1. Turn Voyager off.

2. Attach the AC adapter to Voyager. Voyager must be connected to the AC adapter in order to download firmware.

3. Connect Voyager to the PC as described in *Connecting the PC to Voyager* on page 107.

4. Open your communications software.

   If you are using HyperTerminal, start Windows and then start HyperTerminal. HyperTerminal may be in the Accessories Program Group. Its location will depend on how you have set up Windows. Double-click Hypertrm.exe to run the program.

5. Create and save a configuration file, so that each time you use the communications software with Voyager you can load this file. Enter a name for your configuration file, then select an icon and press OK.

6. In HyperTerminal, the Phone number dialog box will now open, move to the last option, **Connect Using** and select **direct connection**.

7. Select the port to which Voyager is connected and click **OK**.

   Select **COM2** if you are using COM2.

8. Set the following:

Bits per Second (bps)	9600
Data Bits	8
Parity	None
Stop Bits	1
Flow Control	None

9. Click **OK**.

10. Save your configuration file.

    The next time you open the HyperTerminal window, select your configuration file instead of Hypertrm.exe. This will load HyperTerminal and set it up to send data to Voyager.

11. To configure Voyager to receive new firmware, switch Voyager on, while pressing the leftmost, and two rightmost soft keys, as shown in Figure 18.

    The display will be very dim, and the Ready LED will be on.

    If the unit has been successfully connected a series of characters may be displayed. This verifies the connection between the PC and Voyager.

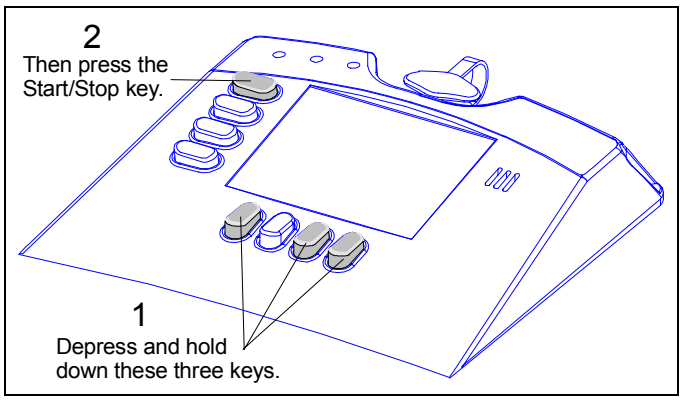


Figure 18 Configuring Voyager to Receive Firmware

12. The file is in binary format so select the appropriate protocol. In HyperTerminal, open the Transfers menu and select **Send File**, enter the **Location** and **Name** of your file, select **1KXmodem** as the protocol and click **Send**.

    Your communication software will display a window showing the transmission status. When the file has been sent the dialog box will close.

    Once the file has been completely downloaded, the three LEDs on the Voyager will light in sequence. The Green LED will flash initially, then the Yellow LED, lastly the Red LED will flash. The LEDs indicate that Voyager has erased its old program and installed the new one.

13. Voyager will display the “System Reset, cold started” dialog box. Press the Exit button.

14. Download your assay using SiteChart and allow 30 minutes for Voyager to stabilize and then calibrate the instrument.

Updating Assays

Due to the nature of gas chromatography, it is necessary to update the assay information periodically. If you are using a single assay and calibrating the instrument daily this will not be too difficult. If you are using more than one assay, it becomes more important to update the assays that you do not use frequently. If this is done you will be able to load the assay when it is required and calibrate the instrument quickly.

If the assays are not maintained, then you will need to update all the library information before you will be able to accurately calibrate each assay library. Although this is not difficult, it can be time consuming. If the instrument is to be used on short notice, it is imperative that you update your assays on a monthly basis or more frequently as necessary.

In order to update the assay you must have calibration gas for each assay. If you have customized an assay for a specific application you may only need to update your custom assay. If on the other hand, you may need all the assay compounds at some time in the future you must update all assay compounds. In either case, the calibration gas must contain all the compounds of interest.

NOTE: *Always update the copy of the assay that is saved on your local drive. Do not update the original disk.*

Updating Compound Retention Time and Response

The following procedure will update retention time and response information for each library compound. Response information will be updated based on the single concentration contained in the calibration gas.

NOTE: *This procedure is performed with the SiteChart software, see the chapter starting on page 99, for more information.*

1. You must use a PC and the SiteChart software to update the assays.

2. Turn Voyager on.

3. In SiteChart, select the Assay tab.

4. Open the assay and click **Send to Voyager**.

   Once the file has been downloaded, allow at least 30 minutes for Voyager to reach the assay set points.

5. Select the first column/detector pair.

   If your application uses 2 or 3 columns you must repeat this procedure for each column.

   If you are using the ECD, you must repeat this procedure for each ECD library.

6. Run a chromatogram on the selected column/detector pair.

   The chromatogram must contain all the compounds listed in your library.

7. Select the **Assay** tab, and select **Open** from the File menu to open the chromatogram that was just run.

8. Select **Re-integrate** from the Analyzer menu to re-integrate the chromatogram.

   Compounds matching library information will be identified.

9. Click on the first compound in the library.

10. Review the data in the library information box.

    Compounds present in the calibration gas must be selected for calibration. Compounds that are not present in the calibration gas must be removed from the library.

NOTE: *All compounds contained in the library must be contained in the calibration gas.*

11. Ensure you have entered the correct calibration concentration.

    This is the concentration of the compound in your calibration gas.

    Blue dashed lines will be displayed where SiteChart is expecting to find the compound.

12. If the compound peak is the only peak within the retention time window, click **Update** or double-click on the peak to open the Update dialog. If the information in the box is not correct, enter the correct data and click **OK**.

    OR

    If the compound peak is not within the retention time window or if there are other peaks in the retention time window, drag the center, blue, dashed line to the desired peak and the retention time will be updated automatically.

13. Repeat this procedure for each library compound.

14. Select **Re-integrate** from the Analyzer menu.
    Each compound should be correctly identified.

15. If you are using another column for your application, repeat this procedure for the next column.

16. Save the assay and then send it to Voyager.

17. Using SiteChart, switch to the **Instrument** tab and run an analysis on each column.

18. Ensure all compounds are correctly identified and then use these analyses to calibrate Voyager.

Updating the Calibration Curve

After you have updated the compound retention times you can also update the calibration curve for each library compound. It is not necessary to update the calibration curves, but multiple point calibration will provide the most accurate response.

1. In the SiteChart software, select the **Assay** tab.

2. Select the column/detector combination required for your compound.
   Ensure your compound is already listed in the library.

3. Ensure Voyager is on and ready for operation.

4. Connect a sample to the Sample In port and begin a run.

5. When the analysis is complete, select the **Assay** tab and use **Open** from the File menu to open the file that was just run.

   The chromatogram will be displayed in the window

6. Double-click on the peak in the chromatogram and enter the concentration.

7. Normally, you will use a linear calibration curve, select **Linear** and SiteChart will update the calibration curve to incorporate the new point.

8. If you have more than one compound at a different concentration then repeat the procedure for the other peaks in the chromatogram.

9. Perform another run at another concentration and store the compound and repeat this procedure for all available concentrations.

10. If you need to remove a concentration point, select the point in the area/concentration table and click **Erase**.

During calibration, the single point that is contained in the calibration gas is used to update the curve.

Backup Assay Files

Make a copy of all the updated assay files and store this backup disk in a safe place with the original assay disk. In addition to the assay file (.app) you should also store the .pid and .ecd files that were used to update the assay.

Each time you update the assay information using the procedures above, you must copy the updated assay and related files to your backup disk.

NOTE: *Do not copy the updated files onto the original assay disk.*

Always retain the original assay, as it contains the reference library. If for some reason you must use the original assay, you must update the library information. Remember to copy the original files from the disk to your local drive and then update them.

Troubleshooting

Voyager fault conditions and the necessary corrective action are listed in this chapter. In addition, basic troubleshooting procedures are provided for some problems that may occur during normal operation.

If you have a service related question about Voyager, consult this manual first. If you cannot find the answer in this documentation, contact the PerkinElmer Photovac Service Department.

When you call, you should have your Voyager in front of you. You should also have this manual at hand. Lastly, please have the following information ready:

- A description of what happened and what you were doing when the problem occurred.
- Any corrective action that you have already tried.
- The exact wording of any messages that appeared on the display.

GC Fault Conditions

If there is more than one fault occurring at a time, the instrument will cycle through them and display them one at time until they are corrected. If one of three critical faults occurs then analyses will stop being run until the fault clears. The three critical faults are: Lamp Fault, Oven Not Ready Fault and Pressure Fault.

Lamp Fault

Cause: The UV lamp could not be started.

Action: Turn Voyager off and then on again and allow the lamp to tune. If the fault persists, replace the lamp as outlined *Replacing the UV Lamp or Installing a New One* on page 258.

Oven Not Ready Fault

Cause: The oven is not within 1 °C of the set temperature.

Action: From a cold start the oven will require 20-30 minutes to reach the set temperature. If you have loaded a new method or manually adjusted the oven temperature allow 20-30 minutes for the oven to reach the set point and stabilize.

Cause: If you are in ECD view, this fault refers to the ECD oven.

Action: From a cold start, both the column oven and the ECD oven will require 20-30 minutes to reach the set temperature. If you have loaded a new method or manually adjusted the oven temperature allow 20-30 minutes for both ovens to reach the set point and stabilize.

If the ECD reaches its set temperature before the column and PID, the Oven Not Ready Fault will clear, but an oven fault condition remains. A fault status will be displayed until the column and PID reach their set point.

Cause: The ambient temperature is below 0 °C (32 °F) or above 40 °C (105 °F).

Action: Move Voyager to a more controlled environment: indoors or inside a vehicle.

Pressure Fault

Cause: The pressure in the internal carrier gas cylinder is low.

Action: Refill the internal tank as described in *Filling the Internal Cylinder* on page 44 or connect the instrument to an external supply of carrier gas as described in *Connecting Carrier Gas* on page 48.

Cause: The external supply of carrier gas is not connected properly.

Action: Ensure there are no leaks in the supply lines and that the delivery pressure is set to 100 psig.

Cause: The Voyager is not within 0.5 psi of its set pressure.

Action: Verify that pressure is set between 4 and 14 psi. If it is set correctly, contact PerkinElmer Photovac Technical Support.

Calibration Fault

Cause: The last calibration run was unsuccessful. Depending on the source of the problem there are different ways to correct this fault.

Action: If pressurized calibration gas is being used, ensure the delivery pressure is maintained at no more than 14 psig.

Cause: Calibration gas has deteriorated.

Action: Ensure the calibration gas is still of a reliable concentration and that all compounds are still contained in the calibration gas.

NOTE: *Due to the nature of some compounds, some calibration mixes are not stable for extended periods. Check with your specialty gas supplier for details.*

Cause: Calibration compounds are not selected for calibration in the library.

Action: Ensure the compounds contained in the calibration mix are enabled in the library.

Cause: Compounds stored in the library are not being used for calibration.

Action: Open the library and enter the concentration of each compound in the calibration gas.

Cause: Calibration peaks are not being recognized.

Action: If the method has been changed, that is flow rates, oven temperature, etc., calibration peaks may have moved out of the peak recognition window. You should clear the library, run a chromatogram with the new settings and store the compounds of interest in the new library. If the peaks have drifted out of the peak recognition window, you must update the library values, see *Updating Library Information* on page 121.

Low Battery Fault

Cause: The battery pack must be recharged.

Action: Connect the instrument to an AC supply using the AC adapter or replace the battery pack with a fully charged one as discussed in *Battery Pack* on page 40.

Datalogger Full Fault

Cause: The internal memory of the Voyager is full.

Action: Delete any old analyses. If you need all the information in the datalogger, download the contents of the datalogger to PC running the SiteChart software. The contents of the datalogger is automatically deleted after the contents is downloaded to the PC.

Ambient Temp Fault

Cause: Ambient temperature is outside of operating temperature range.

Action: Move Voyager to a controlled environment, that is, in a vehicle with the heating or air conditioning running or indoors, or bring the sample to Voyager in gas bags, glass vessels or syringes.

Over Range Fault

Cause: The PID or ECD is saturated.

Action: Saturation has occurred when the offset level is greater than 800 mV. At this point the signal level can no longer be set to 10% of full scale at the start of an analysis. Saturation can also occur if many high concentration samples are analyzed in succession. Allow the detector to flush until the offset level returns to 200-800 mV. If necessary, increase the pressure and flush the detector as described in *Purging the ECD* on page 267.

Chromatographic Troubleshooting

Problem: No peaks appear

Cause: Improper method settings.

Action: Ensure the correct Method is loaded or check that the foreflush duration is long enough to allow the sample to fill the loop and clear the precolumn before backflush begins.

Cause: Leak in the injection port.

Action: Replace the injection port septum as described in *Replacing the Injection Port Septum* on page 261.

Cause: If syringe injection is being used, the syringe needle may be blocked.

Action: If the syringe plunger does not move smoothly this is an indication that the needle is blocked. Use the fine wire supplied with the syringe to clean the needle or replace the needle.

Cause: The sample was injected onto the wrong column.

Action: Ensure you have selected the correct column for your application.

Cause: No sample at sample in port.

Action: If you are using a gas bag, ensure the gas bag valve is open.

Cause: Sample inlet filter is blocked.

Action: Replace the sample inlet filter as described in *Replacing the Sample Inlet Filter* on page 255.

Cause: The filter in the telescoping sample probe is blocked.

Action: Replace the filter in the telescoping sample probe, as described in *Replacing the Filter* on page 53.

Problem: Sensitivity is too low

Cause: Calibration gas pressure is low.

Action: Check the calibration gas pressure and replace the tank if necessary.

Cause: Incorrect calibration gas.

Action: Ensure the calibration gas contains all of the compounds listed in the library. Each library compound must be identified as a calibration compound.

Cause: Calibration gas is not pressurized properly.

Action: Ensure the delivery pressure is maintained at no more than 14 psig.

Cause: Calibration gas has deteriorated.

Action: Replace the calibration gas tank.

NOTE: *Some calibration mixes are not stable for extended periods. Check with your specialty gas supplier for details.*

Cause: UV lamp is failing.

Action: Replace the UV lamp, as detailed in *Replacing the UV Lamp or Installing a New One* on page 258.

Cause: The ECD is contaminated.

Action: Set the detector temperature to 80 °C and increase the pressure to 14 psi. Allow the detector to purge under these conditions for at least 8 hours as detailed in *Purging the ECD* on page 267, or contact the PerkinElmer Photovac Service Department.

WARNING

Do not open the instrument or attempt to remove the ECD. If the ECD must be removed from the instrument, contact the PerkinElmer Photovac Service Department.

Cause: Sample inlet filter is dirty.

Action: Replace the sample inlet filter as described in *Replacing the Sample Inlet Filter* on page 255.

Cause: The filter in the telescoping sample probe is blocked.

Action: Replace the filter in the telescoping sample probe, as described in *Replacing the Filter* on page 53.

Cause: Improper method settings.

Action: Ensure the correct Method is loaded or check that the foreflush time is long enough to allow the sample to fill the loop and clear the precolumn before backflush begins.

Cause: Leak in the injection port.

Action: Replace the injection port septum as detailed in *Replacing the Injection Port Septum* on page 261 or ensure the injection port retainer has been tightened down. The retainer should be finger-tight, do not over- tighten.

Cause: If syringe injection is being used, the syringe needle may be blocked.

Action: If the syringe plunger does not move smoothly, the needle may be blocked. Use the fine wire supplied with the syringe to clean the needle or replace the needle.

Cause: Pieces of cored septum have fallen down inside the injection port.

Action: Remove the injection port and clean it as outlined in *Cleaning the Injection Port Assembly* on page 262.

Problem: Peak appears but is not recognized

Cause: Compounds have drifted from original assay retention time values.

Action: Update the compound library and once the library has been updated save the new values. You must do this for each column/detector pair.

Cause: Peak is not stored in the library.

Action: Ensure the compound peak is stored in the library.

Cause: Retention time window is too small.

Action: Adjust the window percent as discussed on page 119.

Cause: The sample was injected onto the wrong column.

Action: Ensure you have selected the correct column for your application. Refer to the user notes provided with your assay.

Cause: Flow rates are not set correctly.

Action: Ensure the pressure settings are correct for your application. Refer to the user notes supplied with your assay.

Problem: Peaks appear too slowly

Cause: Pressure is too low resulting in low detector flow rates.

Action: Check for a pressure fault and ensure the internal carrier gas cylinder is full, or ensure the pressure setting is correct for the selected method.

Cause: Temperature is too low.

Action: Increase the oven temperature and ensure the temperature setting is correct for the selected method. Refer to the user's notes supplied with your assay. Allow 20 to 30 minutes for the instrument to stabilize.

Cause: The sample was injected onto the wrong column.

Action: Ensure you have selected the correct column for your application. Refer to the user notes provided with your assay.

Problem: Peaks appear too quickly

Cause: Pressure is too high resulting in high detector flow rates.

Action: Adjust the carrier gas pressure and ensure the pressure setting is correct for the selected method. Refer to the user's notes provided with your assay.

Cause: Column temperature is too high.

Action: Reduce the oven temperature and ensure the temperature setting is correct for the selected method. Allow 20 to 30 minutes for the instrument to stabilize.

Cause: The sample was injected onto the wrong column.

Action: Ensure you have selected the correct column for your application. Refer to the user notes provided with your assay.

Problem: Baseline drifts up and down

Cause: Instrument is adapting to large temperature changes.

Action: Increase the oven temperature to ensure isothermal conditions. Allow the instrument to stabilize for 20 to 30 minutes.

Cause: Instrument is adapting to change of the PID sensitivity (gain switch).

Action: Increase the pump time to 20 seconds. After the gain is switched, Voyager begins to stabilize the offset during the pump time.

Cause: Column is recovering from earlier contamination.

Action: Increase the pressure and flush the column, as detailed in *Flushing the Columns* on page 263.

Cause: Components of the last analysis are still on the column.

Action: Purge the column as above, but decrease the backflush duration to flush out the heavier compounds. If the heavier compounds must be detected, adjust the analysis time so these compounds have enough time to clear the column. Also, ensure you have selected the correct column for your application.

Cause: Contamination in the external carrier gas cylinder.

Action: Switch to an alternate carrier gas tank.

Cause: Contamination in the internal carrier gas cylinder.

Action: Purge the internal tank as outlined in *Purging the Internal Carrier Gas Cylinder* on page 266.

NOTE: *To prevent contamination from entering Voyager's pneumatic system, do not allow the internal tank to empty completely.*

Cause: Peaks are appearing from the previous analysis.

Action: Decrease the foreflush time or increase the analysis time.

Cause: Blockage at the detector vent ports.

Action: Ensure the ports are not covered or blocked in any way.

The detector out ports vent the effluent from the PID (port 1) and ECD (port 2). The pressure set by the method will determine the outlet flow rates at these ports. If the detector is not in use Voyager supplies a maintenance flow to ensure the detector is ready for operation.

Samples drawn by the pump to fill and flush the sampling system are vented through the pump out port. The flow though this port is approximately 250 ml/min when the pump is on.

The two columns that are not in use are flushed constantly with approximately 1 mL/min. The two columns are both vented through the vent out port.

Cause: The ECD is contaminated.

Action: Set the detector temperature to 80 °C and increase the pressure to 14 psig. Allow the detector to purge under these conditions for at least 8 hours as detailed in *Purging the ECD* on page 267, or contact the PerkinElmer Photovac Service Department.

WARNING

Do not open the instrument or attempt to remove the ECD. If the ECD must be removed from the instrument, contact the PerkinElmer Photovac Service Department.

Cause: Pieces of cored septum have fallen down inside the injection port.

Action: Remove the injection port and clean it as outlined in *Cleaning the Injection Port Assembly* on page 262.

Problem: There are negative dips following large positive peaks in the chromatogram

Cause: The ECD is contaminated.

Action: Set the detector temperature to 80 °C and the increase the pressure to 14 psi, or contact the PerkinElmer Photovac Service Department.

WARNING

Do not open the instrument or attempt to remove the ECD. If the ECD must be removed from the instrument, contact the PerkinElmer Photovac Service Department.

Problem: Signal level too high

Cause: Components of the last analysis are still on the column.

Action: Purge the column and decrease the backflush duration to flush out the heavier compounds. If the heavier compounds must be detected, adjust the analysis time so these compounds have enough time to clear the analytical column, or ensure you have selected the correct column for your application.

Cause: The ECD is contaminated.

Action: Set the detector temperature to 80 °C and the increase the pressure to 14 psi, or contact the PerkinElmer Photovac Service Department.

WARNING

Do not open the instrument or attempt to remove the ECD. If the ECD must be removed from the instrument, contact the PerkinElmer Photovac Service Department.

Problem: Peak cannot be integrated

Cause: Min Area or Min Height values are set too high.

Action: Lower the values of Min Area or Min Height. If you are not using auto-integrate, turn the option on and re-integrate the chromatogram.

Problem: A value of zero is displayed, even though a valid number was entered

Cause: **Exit** was pressed, instead of **Enter Menu** to confirm the entry.

Action: Type the number into the input box, ensure it is correct and then press **Enter Menu**.

Cause: **Exit** was pressed before the value was complete.

Action: Type the number into the input box, ensure it is correct and then press **Enter Menu**.

Cause: The value you have entered is beyond the allowable range for the instrument

Action: Type a valid number into the input box, ensure it is correct and then press **Enter Menu**.

8 Assay 1 User Notes

An Overview of Assay 1

Assay 1 consists of 40 compounds that belong to the TO-14 priority pollutant list. Voyager has been configured to separate and resolve as many of these target compounds as possible. However, with the standard method there are some co-elutions. As this method has been optimized to separate as many of these 40 compounds as possible, this method may be impractical if your compounds of interest are a small subgroup of the Assay 1 compounds.

An electron capture detector (ECD) is available for Voyager. The ECD must be installed in order to detect some of the compounds to which the PID is less sensitive. Compounds identified as ECD compounds may not be detectable if your instrument does not contain an ECD.

The information in these user's notes will help you determine how to create your own library of compounds using the information that has been stored in the Assay 1 reference library.

The Assay 1 Disk

Two types of files are included on the assay disks. Application (or method) files have the extension .app. Method files are loaded through the Assay tab in the SiteChart software and are used to program Voyager.

Chromatograms from the photoionization detector are identified as .pid files. Assay1A.pid, Assay1B.pid and Assay1C.pid are sample chromatograms from your instrument. Chromatograms from the electron capture detector are identified as .ecd files. Assay1A.ecd, Assay1B.ecd and Assay1C.ecd are also sample chromatograms from your instrument. The .ecd files are only included if an ECD has been installed in your instrument.

- Assay1.app
- Assay1A.ecd
- Assay1B.ecd
- Assay1C.ecd
- Assay1A.pid
- Assay1B.pid
- Assay1C.pid

➢ Make a copy of all the files on the assay disk and use this as your working disk. Store the original disk in a safe location.

Installation

1. Copy the files onto the PC as described in *Installing your Assay Disk* on page 106.

2. Load the assay into Voyager as described in *Loading an Assay into Voyager* on page 109.

NOTE: *The Assay 1 method is specific to an Assay 1 instrument. You cannot install components of Assay 1 on an instrument configured for Assays 2 through 7.*

Compound Separation

Separation of the 40 compounds is accomplished in three separate runs in which the heavy, mid-range, and light compounds of the sample are directed to Columns A, B, C, respectively, for analysis.

The heavy compounds are analyzed on Column A. Any lighter compounds present in the sample are not well separated and elute as an early series of peaks. The integration delay can be used to prevent these peaks from being included in the peak report and from being identified in the chromatogram. See Figure 19 and Figure 20.

For a run on Column A, the analytical column is also the precolumn. Backflush can only begin after the last compound of interest elutes. The system must then backflush, for a time slightly greater than the retention time of the last compound of interest. The resulting analysis time should be approximately twice the backflush time.

The maximum Voyager analysis time is 3200 seconds. If any heavy compounds have not been backflushed from Column A by this time, it may be necessary to delay the start of the next analysis until the necessary time has elapsed (2 x backflush time).

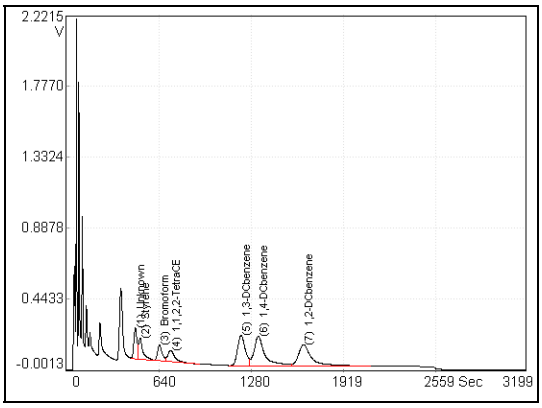


Figure 19 Column A Compounds on the PID

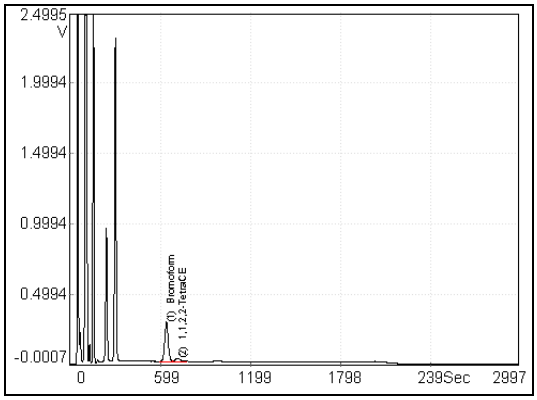


Figure 20 Column A Compounds on the ECD

Figure 19 shows the six compounds analyzed on Column A. Two of these are detected by the ECD, as shown in Figure 20.

The mid-range compounds are analyzed on Column B, with Column A acting as the precolumn. The sample is injected onto Column A, and the heavy compounds are prevented from entering Column B by adjusting the backflush time. The light and mid-range compounds are allowed to pass from Column A to Column B. Before the heavy compounds are able to pass into Column B, the flow is reversed, and the heavy compounds are backflushed off Column A.

Some separation of mid-range compounds occurs on Column A, with the majority of the separation occurring on Column B. Any light compounds present in the sample are not separated and elute as an early peak, well separated from the Column B compounds. The integration delay can be used to prevent this composite peak from being included in the peak report.

The PID detects all of the 19 compounds analyzed on Column B, Figure 21 shows 12 of these. The ECD detects six of the 19 compounds, Figure 22 shows three of these.

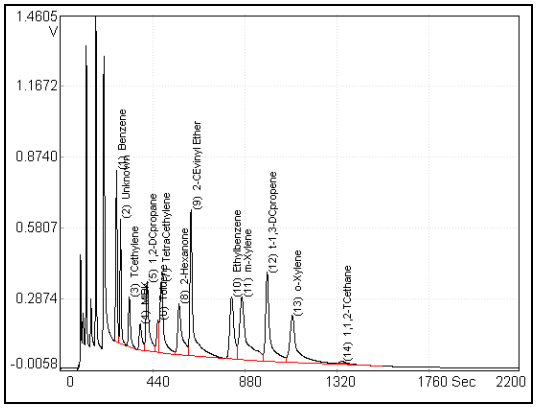


Figure 21 Column B Compounds on the PID

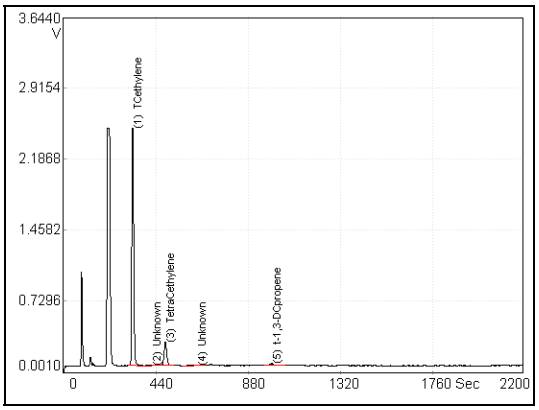


Figure 22 Column B Compounds on the ECD

The light compounds are analyzed on Column C, with Column A acting as the precolumn. As before, the mid-range and heavy compounds are prevented from entering Column C by adjusting the backflush time. In this case only the light compounds are allowed to pass from Column A to Column C, all other compounds are backflushed out of the system. No real separation of the light compounds occurs on Column A. All of the separation occurs on Column C.

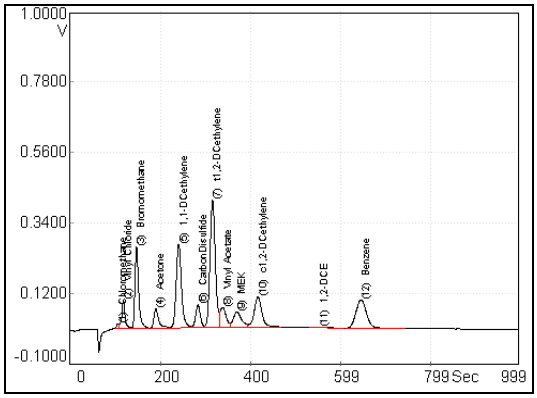


Figure 23 Column C Compounds on the PID

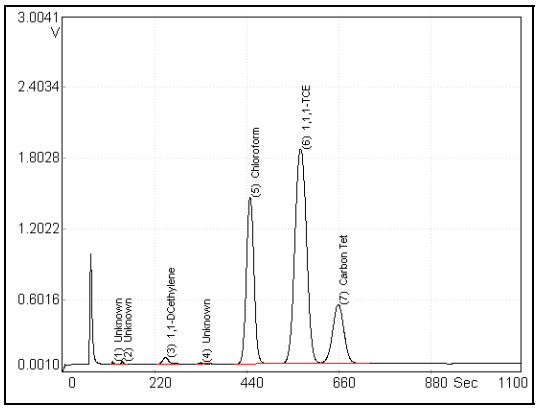


Figure 24 Column C Compounds on the ECD

The PID detects 16 of the 17 compounds analyzed on Column C, Figure 23 shows 12 of these. The ECD detects six of the 16 compounds, Figure 24 shows four of these.

Co-elutions

Assay Wizard runs automatically when you load an assay that contains co-elutions. It will prompt you to select one compound from a list of possible co-elutions.

1. Select a single compound of interest from each list.

2. Save this modified application file to a different filename.

NOTE: *Bypassing Assay Wizard may result in co-eluting compounds being misidentified by Voyager.*

Whether or not a compound pair will co-elute will depend on the instrument and the relative concentrations of the components within the sample. Often co-elutions can be resolved by modifying the standard method, if the sample matrix permits.

There are 5 possible co-elutions on Column B:

- 1,2-dichloropropane and 1,2-dichloroethane - These compounds are separated on Column C, using the standard method.

- Toluene and tetrachloroethylene - These compounds may be separated by modifying the Column B method.

  They could also be analyzed on Column A.

  Tetrachloroethylene can be quantified on the ECD if an ECD has been installed.

- 2-Choroethyl vinyl ether and cis-1,3-dichloro-propene - These compounds are separated on Column A using the standard method, and may by separated by modifying the Column B method.

- m-Xylene and p-xylene - These compounds cannot usually be resolved.

  You can try modifying the Column B method to separate these compounds, but that may in turn effect other separations.

- o-Xylene and chlorobenzene - These compounds may be separated by modifying the Column B method.

There are 5 possible co-elutions on Column C.

- Bromomethane and chloroethane - Chloroethane and bromomethane co-elute on all 3 columns and cannot be resolved by Voyager.
- Dichloromethane and 1,1-dichloroethylene - These compounds are separated on Column B, using the standard method.
- t-1,2-Dichloroethylene and vinyl acetate - These compounds may be separated on either Column B or C, using modified methods.
- 1,2-Dichloroethane and 1,1,1-trichloroethane - These compounds are separated on Column B, using the standard method.
- Carbon tetrachloride and benzene - These can be resolved by the detectors, as the PID is not sensitive to carbon tetrachloride, and the ECD does not detect benzene.

NOTE: *Some of the co-elutions listed above may actually be resolved on your specific instrument.*

Compound Library

There are three standard compound libraries - one for each column. The libraries contain retention time and response information for each of the assay compounds.

These libraries have been determined for the Assay 1 standard method, if the method is altered, these libraries are no longer valid and a new library must be created, identifying the compounds with their new retention times and calibration information. For example, if the column temperature of Column B is increased, the retention times in the Column B library are no longer valid, since compounds will be eluting faster than they would in the standard method. You would have to run the compounds with the new settings and store the compounds in the Library, as discussed in *Compound Library* on page 120.

Assay 1 Standard Method

The Assay 1 standard method is installed on your Voyager and this method includes settings for each column. The table below provides typical settings, the exact values will be specific to your instrument.

	Column A	**Column B**	**Column C**
Method			
Analysis Time (S)	3200	2100	1000
Oven Temperature (°C)	60	60	60
ECD Oven Temp. (°C)	60	60	60
Pressure (psi)	8	8	8
PID State	High Sensitivity	High Sensitivity	High Sensitivity
ECD State *(if installed)*	On	On	On
Injection Method			
Inject Method	Loop Injection	Loop Injection	Loop Injection
Inject Time (S)	2	2	2
Pump Time (S)	20	20	20
Backflush Time (S)	1810	480	115
PID Integration Method			
Automatic Integration	Disabled	Disabled	Disabled
Slope Up (mV/S)	0.5	0.5	0.3
Slope Down (mV/S)	1.0	1.0	1.0
Min. Height (mV)	0.0	0.0	0.0
Min. Area (mV S)	0.0	0.0	0.0
Filter Level	3	3	3
Integration Delay (S)	400	250	100

ECD Integration Method			
Automatic Integration	Disabled	Disabled	Disabled
Slope Up (mV/S)	1.0	0.5	1.0
Slope Down (mV/S)	1.0	1.0	1.0
Min. Height (mV)	0.0	0.0	0.0
Min. Area (mV S)	0.0	0.0	0.0
Filter Level	2	2	2
Integration Delay (S)	400	250	100

Standard Assay Library Compounds

The table below lists all the Assay 1 compounds alphabetically. Long compound names have been abbreviated to meet the 15 character limit of Voyager's display. The table also shows the abbreviations that will appear in the compound library.

Compound Name	Library Name
Acetone	Acetone
Benzene	Benzene
Bromodichloromethane	BDCmethane
Bromoform	Bromoform
Bromomethane	Bromomethane
Carbon Disulfide	CarbonDisulfide
Carbon Tetrachloride	Carbon Tet
Chlorobenzene	Chlorobenzene
Chloroethane	Chloroethane
2-Chloroethyl Vinyl Ether	2-CEvinyl Ether
Chloroform	Chloroform

Compound Name	Library Name
Chloromethane	Chloromethane
Dibromochloromethane	DBCmethane
1,2-Dichlorobenzene	1,2-DCbenzene
1,3-Dichlorobenzene	1,3-DCbenzene
1,4-Dichlorobenzene	1,4-DCbenzene
1,2-Dichloroethane	1,2-DCE
1,1-Dichloroethylene	1,1-DCethylene
c-1,2-Dichloroethylene	c1,2-DCethylene
t-1,2-Dichloroethylene	t1,2-DCethylene
1,2-Dichloropropane	1,2-DCpropane
c-1,3-Dichloropropene	c-1,3-DCpropene
t-1,3-Dichloropropene	t-1,3-DCpropene
Ethylbenzene	Ethylbenzene
2-Hexanone	2-Hexanone
Methyl Ethyl Ketone	MEK
Methyl Isobutyl Ketone	MIBK
Methylene Chloride	Dichloromethane
Styrene	Styrene
1,1,2,2-Tetrachloroethane	1,1,2,2-TetraCE
Tetrachloroethylene	TetraCethylene
Toluene	Toluene
1,1,1-Trichloroethane	1,1,1-TCE
1,1,2-Trichloroethane	1,1,2-TCethane
Trichloroethylene	TCethylene

Compound Name	Library Name
Vinyl Acetate	Vinyl Acetate
Vinyl Chloride	Vinyl Chloride
m-Xylene	m-Xylene
o-Xylene	o-Xylene
p-Xylene	p-Xylene

The tables below show which compounds are typically run on each column for the standard method. Compounds calibrated on one column may be run on another, but optimum separation of all 40 compounds is provided with this method. The library listings are in alphabetical order for ease of reference.

Column A - PID Library

Compound Name	
Bromoform	1,4-Dichlorobenzene
1,2-Dichlorobenzene	Styrene
1,3-Dichlorobenzene	1,1,2,2-Tetrachloroethane

Column A - ECD Library

Compound Name	
Bromoform	1,1,2,2-Tetrachloroethane

Column B - PID Library

Compound Name	
Bromodichloromethane	2-Hexanone
Benzene	MIBK
Chlorobenzene	1,1,2-Trichloroethane
2-Chloroethyl Vinyl Ether	Trichloroethylene
Dibromochloromethane	Tetrachloroethylene
1,2-Dichloroethane	Toluene
1,2-Dichloropropane	m-Xylene

c-1,3-Dichloropropene	o-Xylene
t-1,3-Dichloropropene	p-Xylene
Ethylbenzene	

Column B - ECD Library

Compound Name	
Bromodichloromethane	t-1,3-Dichloropropene
Dibromochloromethane	Tetrachloroethylene
1,2-Dichloroethane	Trichloroethylene

Column C - PID Library

Compound Name	
Acetone	1,2-Dichloroethane
Benzene	1,1-Dichloroethylene
Bromomethane	c-1,2-Dichloroethylene
Carbon Disulfide	t-1,2-Dichloroethylene
Chloroethane	MEK
Chloroform	1,1,1-Trichloroethane
Chloromethane	Vinyl Acetate
Dichloromethane	Vinyl Chloride

Column C - ECD Library

Compound Name	
Carbon Disulfide	1,2-Dichloroethane
Carbon Tetrachloride	1,1-Dichloroethylene
Chloroform	1,1,1-Trichloroethane

Compound Elution Order

The following tables list the elution order and typical retention times for all Assay 1 compounds on each column. This information will be needed if you are customizing the standard method. Heavy compounds, such as 1,2-Dichlorobenzene, are not generally analyzed on the more retentive Columns B and C, since retention times will be unacceptably long.

The information in these tables is for reference only. Retention times will vary on your instrument, and exact retention times for your instrument, are contained in the Assay1.app file.

Compounds with retention times differing by 6% or less are defined as co-elutions and are indicated as such in the tables. Some compounds identified as co-elutions may be resolved on your instrument.

Also indicated are the compounds that are optimally detected with an ECD, these compounds may also be detected on the PID with reduced sensitivity.

Column A Elution Order

Compound	ECD	R.T. (S)	Co-elution
Vinyl Chloride		59	Yes
Chloromethane		59	Yes
Bromomethane		63	Yes
Acetone		68	Yes
1,1-Dichloroethylene		68	Yes
Dichloromethane		72	Yes
Carbon Disulfide		73	Yes
Chloroethane		73	Yes
t-1,2-Dichloroethylene		74	Yes
Vinyl Acetate		77	Yes

Compound	ECD	R.T. (S)	Co-elution
Methyl Ethyl Ketone		84	Yes
c-1,2-Dichloroethylene		86	Yes
Chloroform	Yes	92	Yes
1,1,1-Trichloroethane	Yes	93	Yes
Carbon tetrachloride	Yes	97	Yes
Benzene		102	Yes
1,2-Dichloroethane		103	Yes
2-Chloroethyl Vinyl Ether		114	Yes
Trichloroethylene		114	Yes
1,2-Dichloropropane		121	No
Bromodichloromethane	Yes	132	Yes
Methyl Isobutyl Ketone		138	Yes
c-1,3-Dichloropropene		150	No
Toluene		159	No
t-1,3-Dichloropropene		178	No
2-Hexanone		184	Yes
1,1,2-Trichloroethane		189	Yes
Tetrachloroethylene		190	Yes
Dibromochloromethane	Yes	231	No
Chlorobenzene		278	Yes
p-Xylene		280	Yes
Ethylbenzene		280	Yes
m-Xylene		281	Yes

Compound	ECD	R.T. (S)	Co-elution
o-Xylene		349	No
Styrene		370	No
Bromoform	Yes	459	No
1,1,2,2-Tetrachloroethane	Yes	506	No
1,3-Dichlorobenzene		832	No
1,4-Dichlorobenzene		908	No
1,2-Dichlorobenzene		1116	No

Column B Elution Order

Compound	ECD	R.T. (S)	Co-elution
Chloromethane		102	Yes
Vinyl chloride		102	Yes
Bromomethane		114	Yes
Chloroethane		123	Yes
1,1-Dichloroethylene		123	No
Acetone		131	No
Carbon Disulfide		141	No
t-1,2-Dichloroethylene		159	No
Vinyl Acetate		176	No
Methyl Ethyl Ketone		188	Yes
1,1,1-Trichloroethane	Yes	189	Yes
Dichloromethane		190	Yes
Carbon Tetrachloride	Yes	232	No
Benzene		235	No
c-1,2-Dichloroethylene		249	No
Chloroform	Yes	269	No
Trichloroethylene		278	No
Methyl Isobutyl Ketone		316	No
1,2-Dichloropropane		345	Yes
1,2-Dichloroethane		357	Yes

Toluene		385	Yes
Tetrachloroethylene		389	Yes
2-Hexanone		453	No
2-Chloroethyl Vinyl Ether		500	Yes
c-1,3-Dichloropropene		525	Yes
Bromodichloromethane	Yes	562	No
Ethylbenzene		650	No
p-Xylene		670	Yes
m-Xylene		688	Yes
t-1,3-Dichloropropene		772	No
o-Xylene		875	Yes
Chlorobenzene		889	Yes
1,1,2-Trichloroethane	Yes	1045	No
Dibromochloromethane	Yes	1265	No

Column C Elution Order

Compound	ECD	R.T. (S)	Co-elution
Chloromethane		136	No
Vinyl Chloride		151	No
Bromomethane		186	Yes
Chloroethane		194	Yes
Acetone		237	No
1,1-Dichloroethylene		299	Yes
Dichloromethane		300	Yes
Carbon disulfide		350	No
t-1,2-Dichloroethylene		387	Yes
Vinyl Acetate		409	Yes
Methyl ethyl ketone		447	No
c-1,2-Dichloroethylene		490	No
Chloroform	Yes	518	No
1,2-Dichloroethane		641	Yes
1,1,1-Trichloroethane	Yes	660	Yes
Benzene		751	Yes
Carbon Tetrachloride	Yes	771	Yes

Creating a Custom Method

Generally, you will not need to run all 40 compounds in the Assay 1 library, you will only be interested in a few compounds specific to your application. You can use the information provided in this document to select your compounds and then the chromatography for your compounds.

There are two ways of creating a custom method. You can modify the library of an existing method or you can optimize the chromatography of an existing method, by changing the method parameters.

General Information

Modifying the library of an existing method is a matter of adding or deleting a compound, performing a calibration and storing the compounds in a custom application file.

Changing the method parameters enables you to create a customized method optimized for your application. However, you must first perform a few analyses to determine the new method's analysis and backflush times.

NOTE: *Do not inject heavy compounds onto Column C. They may be retained for extended periods of time, and may contaminate your column.*

1. Set the Column A backflush time to 1500 seconds, and the analysis time to 3200 seconds, then analyze your target compounds on Column A.

   Column A is the precolumn for all other columns, so the retention times of the target compounds on Column A are used to determine the backflush timing for all columns.

2. The backflush time for a run on Column B or C is the retention time, from Column A, of the last peak you wish to analyze plus 0 to 50 seconds.

   The backflush time for Column A is equal to the retention time of the last peak of interest plus 50 to 200 seconds, typically.

3. Column A analysis time is equal to 2.2 times the Column A backflush time.

   Because Column A is also the precolumn, it must be backflushed for at least as long as it was foreflushed.

4. Column B and C analysis times must meet two criteria; each must be long enough to permit the last target peak to clear the column and the analysis time must also be a minimum of 2.2 times the backflush time, for any given column.

   If an analysis time is too short, for either of the above reasons, peaks may elute during a later analysis.

NOTE: *Voyager's maximum analysis time is 3200 seconds. If a peak elutes after this time on any column, the method must be modified, increasing the temperature or pressure will speed up heavy compounds.*

5. Store all target compounds in the library, and calibrate on them using the new method.

Example - Benzene, Vinyl Chloride and Chloromethane

The following examples use three compounds that can be separated using different methods. Our compounds of interest are benzene, vinyl chloride and chloromethane. To simplify this example we will assume there are no known interference compounds.

In these examples, we will assume that the instrument we are customizing provides the typical retention times listed in the tables below.

Solution 1 - Single Run with Analysis Time = 13 Minutes

In this example we are looking for a method to separate benzene, vinyl chloride and chloromethane in a single analysis.

The analysis time required, determined by benzene's retention time, will be about 13 minutes. A modified method can be set up as follows:

1. Disable columns A and B.

   You must do this on Voyager.

2. Delete unwanted compounds from the Column C library.

3. Save the custom assay under a new name.

4. Send the new assay to Voyager.

   You will have the 3 target compounds in the library.

   Since developing this method did not involve changing any of the critical method parameters such as pressure, temperature or injection time the existing calibration information should still result in peak identification when you run these compounds.

5. Run an analysis and calibrate the library compounds, as discussed in *Calibration* on page 223.

Solution 2 - Two Runs with Analysis Time = 8 minutes

If the 13 minute analysis time is too long, then we can optimize the method for minimum analysis time, noting that:

- Benzene on Column A is well separated from the other compounds of interest.

- Vinyl chloride and chloromethane are only separated on Column C, so these compounds must be run on Column C.

This new method will consist of two runs. The first analysis on Column A will separate benzene from the light compounds. We will then do another run to separate the light compounds on Column C. Benzene will be backflushed off the precolumn (Column A) to minimize the analysis time.

Benzene elutes at about 102 seconds on Column A. The backflush time will be set to approximately 150 seconds for the first run on Column A, this allows a little extra time to ensure the entire benzene peak has cleared the column. To set the analysis time, multiply the backflush time by a factor of 2.2, this allows time for any compounds eluting after benzene to be backflushed out of Column A.

The total analysis time for the first run will be 150 s x 2.2 = 330 s ~ 6 minutes.

Vinyl chloride and chloromethane elute at about 60 seconds on Column A. The backflush time for the second run on Column C can be set to 70 seconds, this allows vinyl chloride and chloromethane to clear the precolumn (Column A). Benzene is still in Column A when backflush begins. Column C elution time for chloromethane is about 135 seconds and about 150 seconds for vinyl chloride. Analysis time on Column C will be about 3 minutes.

This new method provides an analysis time of 9 minutes, a time saving of approximately 4 minutes.

NOTE: *The retention time values provided here are for illustration purposes only.*

You must perform runs on both Column A and C to determine the exact retention times. These values must be determined experimentally before you can modify the method on your instrument.

To setup your instrument with this method:

1. Using the SiteChart software, load the Assay 1 standard method.
   Delete unwanted compounds from all three libraries.

2. On SiteChart's Assay tab, select Column A and set the analysis time to 270 seconds and the backflush time to 120 seconds.
   This provides 150 seconds for backflushing the precolumn.

3. On the Assay tab, select Column C and set the analysis time to 170 seconds and the backflush time to 70 seconds.

4. Save the new method under a new .app filename, and send it to Voyager.

5. On Voyager, enable Columns A and C.

6. In SiteChart, select Column A and perform a run.
   This run will give two peaks. The first peak is the vinyl chloride/chloromethane co-elution at about 60 seconds, the other peak is benzene at 102 seconds. You will need to calibrate benzene on Column A.

7. In SiteChart, select Column C and perform a second run on Column C.

   This run will give two peaks. The first peak is chloromethane at about 135 seconds and the second peak is vinyl chloride at about 150 seconds. You will need to calibrate these two compounds on Column C.

8. The instrument must be calibrated to update retention time and detector response information for the three target compounds.

9. Store the compounds in the custom method file and save the method file.

Column Specifications

Column A	
Length	4 meters (m)
Internal Diameter	0.53 millimeters (mm)
Coating Thickness	2 micrometers (um)
Coating/Packing Material	35% phenyl, 65% methyl phase capillary column (SPB-35)
Column V (TVOC)	
Length	8 m
Internal Diameter	0.25 mm
Coating Thickness	N/A
Coating/Packing Material	blank (deactivated)
Column B	
Length	20 m
Internal Diameter	0.32 mm
Coating Thickness	1.0 um
Coating/Packing Material	WAX phase capillary column (Supelcowax 10™)
Column C	
Length	15 m
Internal Diameter	0.32 mm
Coating Thickness	12 um
Coating/Packing Material	100% methyl silicone phase capillary column

Accurate Concentration Measurement

The following information is provided to assist you in understanding some of the analytical issues regarding the analysis of your target compounds in ambient air.

When you are detecting compound concentrations in air samples using gas chromatography, it is important to recognize that there are various potential sources of error in the measurements. These sources of error combine to give scatter in measured concentrations (measured as precision) and systematic bias to measured concentrations. You must correct for these sources of error or your results will become inaccurate.

Possible sources of error include:

- Peak integration errors.
- Sampling errors.
- Compound dependent adsorption effects.
- Detector response drift over the period of time since the last calibration.
- System accuracy.

All of these effects may contribute to inaccurate measurements in any given set of data.

Peak Integration Errors

Baseline noise, interfering peaks or excessive tailing of the target compound peak can cause problems in starting or stopping the peak integration at the optimum times. These can even cause differences in integration for consecutive runs at the same concentration. Selection of one set of integration parameters over another may result in a nonlinear area versus concentration curve.

It is impossible to completely eliminate integrator effects as a source of error over the broad range of conditions under which Voyager must operate. For this reason, it is essential that you verify the integration results generated by the instrument by examining the chromatograms and re-integrating, if necessary. This is particularly true if the results are being used to make decisions regarding health and safety issues.

Sampling Errors

Sampling errors occur when the concentration of a compound in the gas sample presented to the analytical system is not the same as the original sample.

For example: A Tedlar® bag is filled with styrene and sampled at regular intervals. A graph of measured concentration versus time produces a curve as shown in Figure 25. This measurement sequence lasted for about 8 hours. The last run was performed approximately 8 hours after the initial sequence of runs had been completed. This data trend is symptomatic of adsorption of styrene by the gas bag.

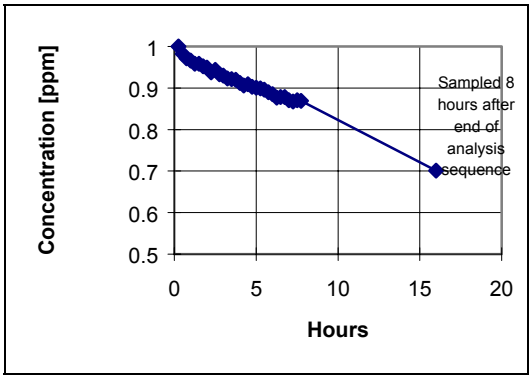


Figure 25 Gas Bag Effect as Measured on a 1 ppm Styrene Sample

If the same concentration of styrene is measured directly from a tank of compressed gas, standard drift effects over the same time period are negligible. If a Tedlar bag is used to store a styrene sample at this concentration, then the analysis results hours later will not accurately reflect the concentration at the time of sampling.

In addition to container effects, there are a variety of other issues regarding sample storage, processing and preparation that can compromise the accuracy of the concentration measurement.

Adsorption

Another potential instrument source of error is sample adsorption by Voyager's analytical system. If this occurs, it will typically be seen as an increase in peak area upon repeated sampling of the component, even after the instrument has been in operation for many hours. The effect is usually concentration dependent, as higher concentrations will supply the demand of a limited number of adsorption sites without a significant percentage of sample loss.

Voyager has been designed to minimize adsorption effects by heating the analytical system. However some compounds may still be problematic at low concentrations.

Detector Response Drift

Detector response drift is caused by drift in the effective UV lamp intensity over time. Although Voyager maintains a constant visible lamp intensity, it is possible that the ionizing spectral lines, located outside the visible range, shift in intensity over time.

Detector response drift will manifest itself as an effect that typically occurs over a longer time period than adsorption and which is not as compound specific as adsorption. Also, it is not affected by the frequency of sampling, unlike adsorption phenomena. Calibration is recommended when the detector response has changed by greater than 10%. This will be approximately 8 hours.

The instrument must be calibrated when Voyager is turned on and should be calibrated at 8 hour intervals thereafter. We recommend that you perform the calibration under similar temperature and humidity conditions as that of the sample.

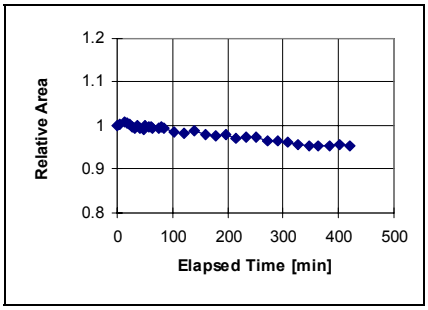


Figure 26 Peak Area Stability for Repetitive Sampling for 100 ppm Isobutylene

This drift characteristic is typical of Voyager's detector response drift, following a 20 minute warm-up period. Although this test is performed with isobutylene, the same approximate, peak area drift can be expected for any of the Assay 1 compounds.

To ensure a measured concentration (at the calibration concentration) is within 10% of the actual value:

1. Calibrate once when the instrument is turned on.

   Allow 30 minutes for the instrument to stabilize before performing the calibration run(s).

2. Calibrate at 8 hour intervals.

Assuming detector response drift is similar for the Assay 1 compounds, you need to calibrate once, immediately following instrument warm-up. Measurement of dry, pure samples at a similar concentration to the calibration concentration should then give a result accurate to within 10% for an 8 hour working period.

As a measuring instrument, Voyager has a non-linear response for many compounds. Therefore, in order to make accurate measurements at concentrations other than the calibration concentration, it is necessary to correct for instrument non-linearity. This can only be done if a multiple point calibration is performed to determine the response of the instrument throughout the concentration range of interest.

If the response curve characteristics are measured in this way, then reasonably accurate measurements can be made.

Assay 2 User Notes 9

An Overview of Assay 2

Assay 2 consists of 9 compounds from the petrochemical refining process. Voyager has been configured to separate and resolve these target compounds.

The Assay 2 Disk

Two types of files are included on the assay disks. Application (or method) files have the extension .app. These method files are loaded through the Assay tab in SiteChart and are used to program Voyager. Assay2.app is the standard method. It provides chromatographic settings so that all compounds can be run on a single column.

Chromatograms from the photoionization detector are identified as .pid files. Assay2.pid is a sample chromatogram of the compounds of interest using Assay2.app.

- Make a copy of all the files on the assay disk and use this as your working disk. Store the original disk in a safe location.

Installation

1. Copy the files onto the PC as described in *Installing your Assay Disk* on page 106.

2. Load the assay into Voyager as described in *Loading an Assay into Voyager* on page 109.

Compound Separation

Separation of the 9 compounds is accomplished in one run on Column B. Column A acts as the precolumn.

The sample is injected onto Column A and any heavy compounds, present in the sample, are prevented from entering Column B by adjusting the backflush time, and only the lighter compounds are allowed to pass from Column A to Column B. Before the heavy compounds are able to pass into Column B, the flow is reversed, and the heavy compounds are backflushed out of Column A.

Some separation of compounds occurs on Column A, with the majority of the separation occurring on Column B, as shown in Figure 27.

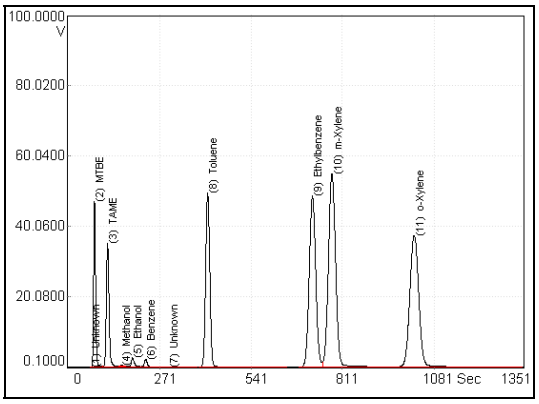


Figure 27 Assay 2 Compounds Run on Column B

Compound Library

Assay Compounds

One compound library is installed in Voyager for Column B. The library contains retention time and response information for each assay compound.

The library has been determined for the Assay 2 standard method. If the method is altered, the library is no longer valid. If the method is modified, a new library must be created, identifying the compounds with their new retention times.

For example, if the column temperature is increased, the retention time in the Column B library is no longer valid, since compounds will be eluting faster than they would in the standard method. You would have to run the compounds with the new settings and store the compounds in the library.

Interference Compounds

Gasoline and its mixture of components is a possible interference. Gasoline is not part of Assay 2, but may be present in your samples. Gasoline will interfere with the early eluting peaks such as MTBE, TAME, methanol and ethanol.

Compounds lighter than the sample compounds are not separated and will elute as an early peak. The integration delay can be used to prevent this composite peak from being included in the peak report as shown in Figure 28.

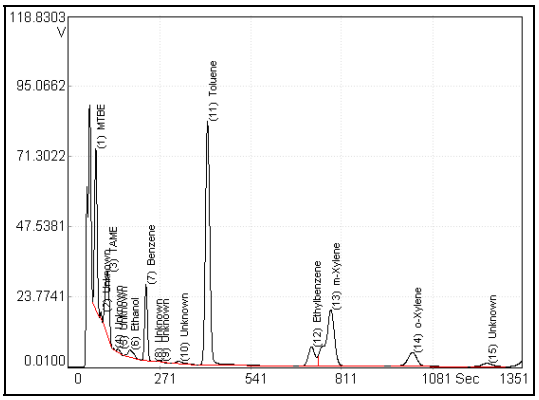


Figure 28 Gasoline as Run on Column B

If gasoline is present, you may want to modify some chromatographic or integration settings to ensure the best possible separation and peak identification.

NOTE: *Gasoline will not be well separated on your system.*

Assay 2 Standard Method

The Assay 2 standard method, Assay2.app, has been customized for and is installed in your Voyager. The typical method parameters for Assay 2 are listed below as are the library compounds for each column and typical retention times and detectable concentration ranges for this method. These values will vary on your instrument.

NOTE: *For maximum accuracy at low concentrations, we recommend that you verify Voyager's integration, and reintegrate manually, if necessary.*

Concentrations outside these specified ranges, especially at the lower end, can be obtained by adjusting the injection time, PID state and integration parameters.

Settings for Assay 2

	Column B
Method	
Carrier Gas	Air
Detector	PID
Analysis Time (S)	1300
Oven Temperature (°C)	60
Pressure (psi)	12
PID State	Low Sensitivity
Injection Method	
Inject Method	Loop Injection
Inject Time (S)	5
Pump Time (S)	20
Backflush Time (S)	300

Integration Method	
Automatic Integration	Disabled
Slope Up (mV/S)	1
Slope Down (mV/S)	1
Min. Height (mV)	0.0
Min. Area (mV S)	0.0
Filter Level	3
Integration Delay (S)	60

Elution Order for Standard Method

Column B	**R.T. (S)**	**Concentration Range (ppm)**	**Co-elution**
Methyl t-butyl ether (MTBE)	78	1 - 100	No
t-Amyl methyl ether (TAME)	117	1 - 100	No
Methanol	155	50 - 500	No
Ethanol	187	100 - 1000	No
Benzene	226	0.03 - 100	No
Toluene	408	0.5 - 200	No
Ethylbenzene	708	1 - 150	No
m-Xylene	763	1 - 150	No
o-Xylene	998	1 - 150	No

NOTE: *The information is for reference only. Retention times may vary significantly.*

Creating a Custom Method

You may not need to run all 9 compounds in the Assay 2 library, you may only be interested in a few compounds specific to your application. You can use the information provided in this document to select your compounds and then optimize the chromatography for your compounds.

There are two ways of creating a custom method. You can modify the library of an existing method. Alternatively, you can optimize the chromatography of an existing method, by changing the method parameters.

General Information

Modifying the library of an existing method is a matter of adding or deleting a compound, performing a calibration and storing the compounds in a custom application file.

Changing the method parameters enables you to create a customized method optimized for your application. However, you must first perform a few analyses to determine the new method's analysis and backflush times.

NOTE: *Do not inject heavy compounds onto Column C. They may be retained for extended periods of time, and may contaminate your column.*

3. Set the Column A backflush time to 1500 seconds, and the analysis time to 3200 seconds, then analyze your target compounds on Column A.

   Column A is the precolumn for all other columns, so the retention times of the target compounds on Column A are used to determine the backflush timing for all columns.

4. The backflush time for a run on Column B or C is the retention time, from Column A, of the last peak you wish to analyze plus 0 to 50 seconds.

   The backflush time for Column A is equal to the retention time of the last peak of interest plus 50 to 200 seconds, typically.

5. Column A analysis time is equal to 2.2 times the Column A backflush time.

   Because Column A is also the precolumn, it must be backflushed for at least as long as it was foreflushed.

6. Column B and C analysis times must meet two criteria; each must be long enough to permit the last target peak to clear the column and the analysis time must also be a minimum of 2.2 times the backflush time, for any given column.

   If an analysis time is too short, for either of the above reasons, peaks may elute during a later analysis.

NOTE: *Voyager's maximum analysis time is 3200 seconds. If a peak elutes after this time on any column, the method must be modified, increasing the temperature or pressure will speed up heavy compounds.*

7. Store all target compounds in the library, and calibrate on them using the new method.

Example - Benzene and Toluene

If we are only interested in benzene at a concentration of approximately 0.5 ppm and toluene at 0.5 ppm, we can customize the method provided.

To customize this method you will need to perform a run on Column B to determine the exact elution time for each compound. You will then use this time to determine the analysis and backflush times.

NOTE: *To simplify this example we will assume there are no known interference compounds.*

Assuming an instrument with elution information as given previously, we will modify the method as follows:

1. Using SiteChart, load the Assay 2 standard method.

   Delete unwanted compounds from the library.

2. Disable Column B.

3. Ensure Voyager is setup and ready to run an analysis.

   The instrument must be connected to carrier gas, and the instrument status must show Ready.

4. Perform a few runs of your sample on Column A.

   One peak should appear, this is the benzene/toluene co-elution at 150 seconds. The peak must completely clear the column to ensure accurate quantitation. This includes any peak tailing.

5. The backflush time must be set so that the compounds of interest clear Column A before backflush begins.

   You will use the retention time of the latest eluting peak to set the backflush time. You cannot begin backflush until the benzene/toluene peak clears Column A, so allow an additional 20 seconds. In this case the backflush time should be set to approximately 170 seconds.

6. To set the analysis time use the retention time of the latest eluting peak and multiply it by 1.1.

   You will not know the exact time until you perform an analysis on Column B, but should set the analysis time to at least 800 seconds to allow all peaks of interest to elute.

7. Send the new method to Voyager and perform a run of your sample.

   Two peaks should appear. The first peak will be the benzene. The next peak will be toluene at approximately 410 seconds. The analysis time should be set to the retention time of the last eluting peak multiplied by 1.1. In this example 450 seconds.

8. Perform a few more runs to ensure your timing is correct.

9. Remove all unwanted compounds from the Column B library.

10. Analysis and backflush time are critical method parameters. The existing library information will become invalid. You must perform a run and store the compounds in the library. If possible store each compound at more than one concentration to obtain a more accurate calibration curve.

11. Perform a run and calibrate benzene and toluene in the Column B library.

12. Save the new method under a new name.

In addition to adjusting the analysis time and the backflush time, you may also want to increase the pressure and the temperature. This will decrease the analysis time significantly. You must ensure there are no interfering compounds that may co-elute with your compounds of interest and that your compounds of interest are well separated.

Column Specifications

Column A	
Length	2.5 meters (m)
Internal Diameter	0.53 millimeters (mm)
Coating Thickness	2 micrometers (um)
Coating/Packing Material	35% phenyl, 65% methyl phase capillary column (SPB-35)
Column V (TVOC)	
Length	8 m
Internal Diameter	0.25 mm
Coating Thickness	N/A
Coating/Packing Material	blank (deactivated)
Column B	
Length	20 m
Internal Diameter	0.32 mm
Coating Thickness	1.5 um
Coating/Packing Material	WAX phase capillary column (Supelcowax 10™)
Column C	
Length	4' x 1/16"
Internal Diameter	0.040"
Coating Thickness	N/A
Coating/Packing Material	1% SP-1000 on 60/80 Carbopack® B (SPB-1)

Accurate Concentration Measurement

The following information is provided to assist you in understanding some of the analytical issues regarding the analysis of petrochemical refinery target compounds in ambient air.

When you are detecting compound concentrations in air samples using gas chromatography, it is important to recognize that there are various potential sources of error in the measurements. These sources of error combine to give scatter in measured concentrations (measured as precision) and systematic bias to measured concentrations. You must correct for these sources of error or your results will become inaccurate.

Possible sources of error include:

- Peak integration errors.
- Sampling errors.
- Compound dependent adsorption effects.
- Detector response drift over the period of time since the last calibration.
- System accuracy.

All of these effects may contribute to inaccurate measurements in any given set of data.

Peak Integration Errors

Baseline noise, interfering peaks or excessive tailing of the target compound peak can cause problems in starting or stopping the peak integration at the optimum times. These can even cause differences in integration for consecutive runs at the same concentration. Selection of one set of integration parameters over another may result in a nonlinear area versus concentration curve.

It is impossible to completely eliminate integrator effects as a source of error over the broad range of conditions under which Voyager must operate. For this reason, it is essential that you verify the integration results generated by the instrument by examining the chromatograms and re-integrating, if necessary. This is particularly true if the results are being used to make decisions regarding health and safety issues.

Sampling Errors

Sampling errors occur when the concentration of a compound in the gas sample presented to the analytical system is not the same as the original sample.

For example: A Tedlar® bag is filled with styrene and sampled at regular intervals. A graph of measured concentration versus time produces a curve as shown in Figure 29. This measurement sequence lasted for about 8 hours. The last run was performed approximately 8 hours after the initial sequence of runs had been completed. This data trend is symptomatic of adsorption of styrene by the gas bag.

If the same concentration of styrene is measured directly from a tank of compressed gas, standard drift effects over the same time period are negligible. If a Tedlar bag is used to store a styrene sample at this concentration, then the analysis results hours later will not accurately reflect the concentration at the time of sampling.

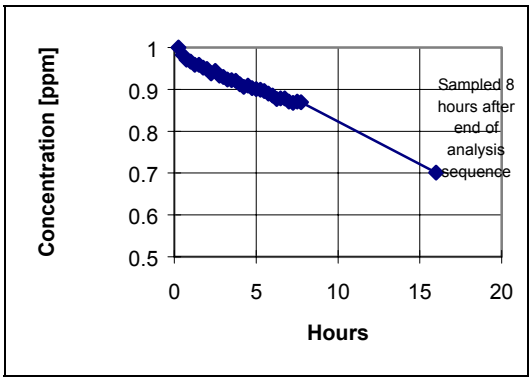


Figure 29 Gas Bag Effect as Measured on a 1 ppm Styrene Sample

In addition to container effects, there are a variety of other issues regarding sample storage, processing and preparation which can compromise the accuracy of the concentration measurement.

Adsorption

Another potential instrument source of error is sample adsorption by Voyager's analytical system. If this occurs, it will typically be seen as an increase in peak area upon repeated sampling of the component, even after the instrument has been in operation for many hours. The effect is usually concentration dependent, as higher concentrations will supply the demand of a limited number of adsorption sites without a significant percentage of sample loss.

Voyager has been designed to minimize adsorption effects by heating the analytical system. However some compounds may still be problematic at low concentrations. Each compound has been tested for adsorption effects and the results are illustrated below. These results were used to generate the precision specifications for Assay 2 compounds.

The instruments being tested had not previously been exposed to the target compound. The analyses were performed with typical Assay 2 method parameters. A bag sample is prepared containing all the Assay 2 target compounds at the indicated concentrations.

The adsorption test itself consists of repetitive sampling (10 runs) and analysis of the indicated compound concentration. The sample is typically obtained either directly from a tank standard or by diluting a tank standard with air to obtain the indicated concentration. The instrument was calibrated and then the 10 runs were performed.

Most of the Assay 2 compounds are stable in a gas bag at the indicated concentrations. However, the methanol peak area and height were observed to decrease over time during this test indicating that the methanol was not stable at the target concentration in the bag and that therefore this approach to quantitating the instrument adsorption effects for methanol would not produce accurate results. The methanol results reported in Figure 31 were generated by sampling a gas stream of 96 ppm methanol produced by dilution from a tank standard.

Test results below, are shown for the Assay 2 compounds as run on one instrument. These results are typical for Voyager.

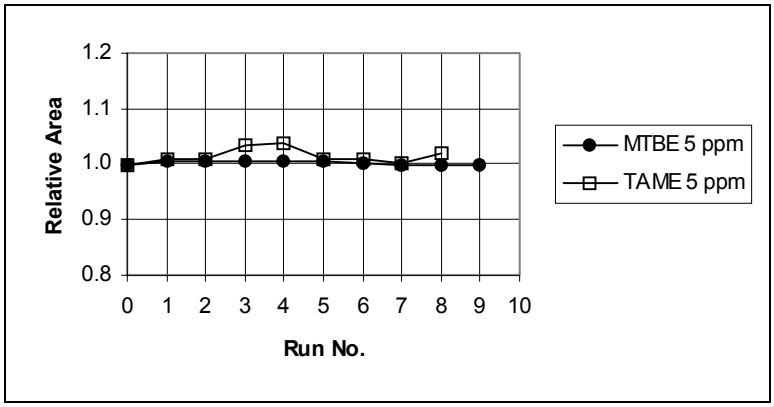


Figure 30 Peak Area Stability for Repetitive Sampling of 5 ppm MTBE and 5 ppm TAME

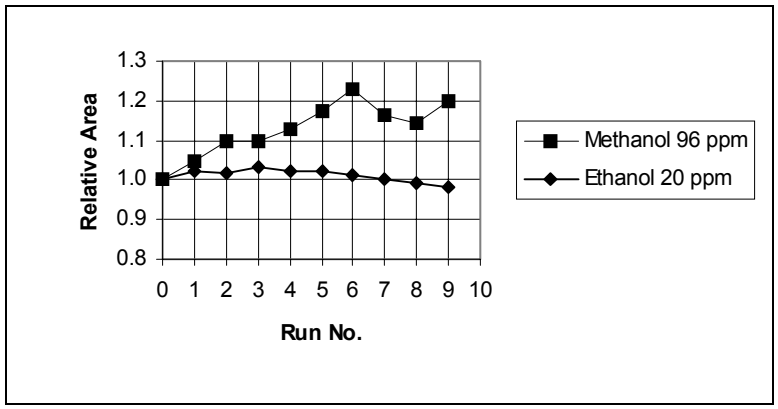


Figure 31 Peak Area Stability for Repetitive Sampling of 20 ppm Ethanol and 96 ppm Methanol

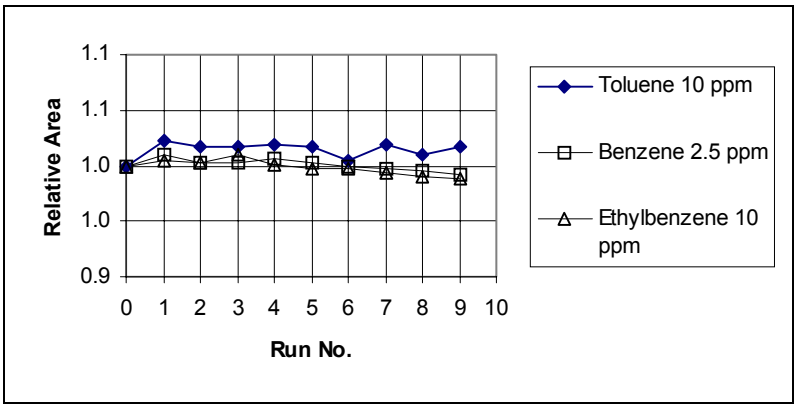


Figure 32 Peak Area Stability for Repetitive Sampling of 10 ppm Toluene, 2.5 ppm Benzene and 10 ppm Ethylbenzene

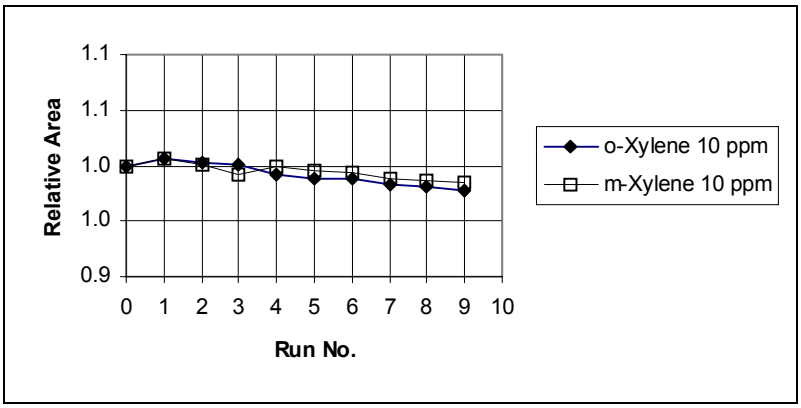


Figure 33 Peak Area Stability for Repetitive Sampling of 10 ppm m-Xylene and 10 ppm o-Xylene

Response Drift

Detector response drift is caused by drift in the effective UV lamp intensity over time. Although Voyager maintains a constant visible lamp intensity, it is possible that the ionizing spectral lines, located outside the visible range, shift in intensity over time.

Detector response drift will manifest itself as an effect that typically occurs over a longer time period than adsorption and which is not as compound specific as adsorption. Also, it is not affected by the frequency of sampling, unlike adsorption phenomena. Calibration is recommended when the detector response has changed by greater than 10%.

The table below provides a recommended maximum operating time before calibration is necessary. The instrument must be calibrated when Voyager is turned on and should be calibrated at the indicated interval thereafter. We recommend that you perform the calibration under similar temperature and humidity conditions as that of the sample.

The calibration information in the table, and the discussion which follows, are applicable only for measurement of dry, pure, sample gases containing the target compounds at approximately calibration concentrations.

Compound	TLV (ppm)	Precision % RSD from Mean *	Calibration Interval**(Hrs)
MTBE	10	0.5@5ppm	8
TAME	0.5	1.6@5ppm	8
Ethanol	0.5	1.2@20ppm	8
Benzene	10	0.5@2.5ppm	8
Toluene	50	0.8@10ppm	8
Methanol	200	5.0@96ppm	8
Ethylbenzene	750	0.5@10ppm	8
m-Xylene	200	0.5@10ppm	8
o-Xylene	100	0.5@10ppm	8
* Based on five consecutive samples ** Interval between calibrations for <10% change in accuracy assuming Voyager is calibrated once immediately after a 20 minute warm up period.			

Table 1 Precision and Calibration Data for Assay 2 Compounds

These calibration times are based on an extended measurement of peak area drift of a generic compound (isobutylene) following instrument warm-up. A Voyager which has been off for an extended period is turned on and set to auto sample and analyze isobutylene on Column B. Isobutylene is a volatile compound and so typically does not show adsorption effects. The observed peak area drift is an indication of detector drift only. The resulting area drift over a period of 400 minutes is shown in Figure 34. The change in peak area over this time period was 5%.

This drift characteristic is typical of Voyager's detector response drift, following a 20 minute warm-up period. Although this test is performed with isobutylene. the same approximate, peak area drift can be expected for any of the Assay 2 compounds. To ensure a measured concentration (at the calibration concentration) is within 10% of the actual value:

1. Calibrate once when the instrument is turned on.

   Allow 30 minutes for the instrument to stabilize before performing the calibration run(s).

2. Calibrate at 8 hour intervals.

Assuming detector response drift is similar for the petrochemical compounds, you need to calibrate once, immediately following instrument warm-up. Measurement of dry, pure samples at a similar concentration to the calibration concentration should then give a result accurate to within 10% for an 8 hour working period.

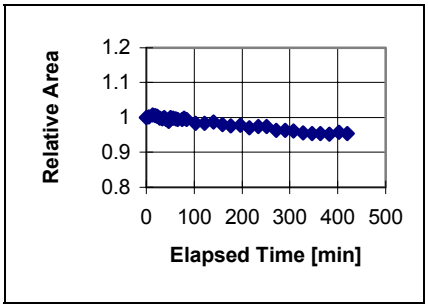


Figure 34 Peak Area Stability for Repetitive Sampling for 100 ppm Isobutylene

The numbers in the table are meant as a guideline. It is possible the instrument may drift more or less rapidly in practice. This will depend on your application and operating conditions. You may need to calibrate more frequently to ensure reliable results.

As a measuring instrument, Voyager has a non-linear response for many compounds. Therefore, in order to make accurate measurements at concentrations other than the calibration concentration it is necessary to correct for instrument non-linearity.

This can only be done if a multiple point calibration is performed to determine the response of the instrument throughout the concentration range of interest.

If the response curve characteristics are measured in this way, then reasonably accurate measurements can be made.

Assay 4 User Notes 10

An Overview of Assay 4

The Assay 4 Disk

Two types of files are included on the assay disks. Application (or method) files have the extension .app. Method files are loaded through the Assay tab in the SiteChart software and are used to program Voyager. Assay4.app is the standard method and it has been installed on your instrument.

Assay4A.app, Assay4B.app, Assay4C.app are versions of the standard method that have been modified to analyze for only one of the compounds. Assay4A.app is for styrene. Assay4B.app is for acrylonitrile and Assay4C.app is for 1,3-butadiene.

- Assay4.app
- Assay4A.app
- Assay4B.app
- Assay4C.app
- Assay4A.pid
- Assay4B.pid
- Assay4C.pid

Chromatograms from the photoionization detector are identified as .pid files. Assay4A.pid, Assay4B.pid, Assay4C.pid are sample chromatograms from each column.

➢ Make a copy of all the files on the assay disk and use this as your working disk. Store the original disk in a safe location.

Installation

1. Copy the files onto the PC as described in *Installing your Assay Disk* on page 106.

2. Load the assay into Voyager as described in *Loading an Assay into Voyager* on page 109.

Compound Separation

Assay 4 consists of 3 compounds that belong to the ABS rubber process. Since the ABS compounds are each analyzed on a different column the chromatography is relatively simple.

Separation of the 3 compounds is accomplished in three separate runs in which the heavy, mid-range, and light compounds of the sample are directed to the appropriate column for analysis.

The heavy compound, styrene, is analyzed on Column A. The separation occurs on Column A, as shown in Figure 35.

Acrylonitrile is analyzed on Column B, with Column A acting as the precolumn. The sample is injected onto Column A and acrylonitrile and 1,3-butadiene are separated from styrene by adjusting the backflush time. These compounds are allowed to pass from Column A to Column B. Before styrene is able to pass onto Column B, the flow is reversed, and styrene is backflushed out of Column A. Some separation occurs on Column A, with the majority of the separation occurring on Column B.

1,3-butadiene is analyzed on Column C. In this case only 1,3-butadiene is allowed to pass from Column A to Column C. The other compounds are backflushed out of the system.

Compound Library

Assay Compounds

Installed in Voyager, there are three standard compound libraries—one for each column. The libraries contain retention time and response information for each of the assay compounds. These libraries have been determined, on your instrument, for the Assay 4 standard method. If the method is altered, these libraries are no longer valid. If the method is modified, a new library must be created, identifying the compounds with their new retention times.

For example, if the temperature of Column B is increased, the retention time in the Column B library is no longer valid, since the compound will be eluting faster than it would in the standard method. You will have to calibrate the compound using the new method and store the compound in the library.

The table below lists the compounds and typical concentration ranges for the standard method. The concentration ranges may be obtained using the standard method. Concentrations outside the specified range, especially at the lower end, can be obtained by adjusting the injection time, PID state and integration parameters. You are limited by the detector sensitivity to the specified compounds.

To obtain maximum accuracy at low concentrations, you should integrate the acrylonitrile peak manually. Verify the integration whenever accurate concentration readings are required.

Compound Name	**Column A**	**Column B**	**Column C**
	Styrene	Acrylonitrile	1,3-Butadiene
Retention Time (min)	5.45	2.58	4.03
Retention Time (S)	327	155	242
Concentration. Range (ppm)	0.5 - 500	2 - 180	0.10 -10

NOTE: *The information in the table is for reference only. Retention times will vary significantly.*

Although nitrogen is specified for Assay 4, you can use zero grade air. The sensitivity of the PID will be reduced by a factor of about 3. This will increase the specified concentration ranges. For example, if you were to use air, the range for acrylonitrile would change to approximately 6 to 540 ppm.

If you are not working at low concentrations, the convenience of using air may outweigh the loss of sensitivity.

Interference Compounds

The compounds listed in the table below are possible interference compounds. These compounds are not part of Assay 4, but may be present in your application.

If you need to add these or any other compounds to the standard assay you must add the compounds to the library, identify them as calibration compounds and calibrate your instrument.

If any of these interference compounds are present in your application, you may want to modify some chromatographic settings to ensure the best possible separation and peak identification.

Column A	**R.T. (min)**	**R.T. (S)**
Benzene	1.23	74
Toluene	2.15	129
Ethyl Benzene	4.02	241
Column C		
1-Butene	3.18	175
Isobutylene	3.64	199
Cis-2-Butene	4.04	220
Trans-2 Butene	4.80	259

NOTE: *The information in the table is for reference only. Actual retention times may vary significantly.*

Assay 4 Standard Method

The tables below provide approximate settings. Exact values will be specific to your instrument.

	Column A	Column B	Column C
Method			
Carrier Gas	N_2, Zero Grade	N_2, Zero Grade	N_2, Zero Grade
Analysis Time (S)	800	420	500
Oven Temperature (°C)	60	60	60
Pressure (psi)	12	12	12
PID State	Low Sensitivity	High Sensitivity	High Sensitivity
Injection Method			
Inject Method	Loop Injection	Loop Injection	Loop Injection
Inject Time (S)	2	10	3
Pump Time (S)	20	20	20
Backflush Time (S)	360	40	30
Integration Method			
Automatic Integration	Disabled	Disabled	Disabled
Slope Up (mV/S)	1.0	1.0	1.0
Slope Down (mV/S)	2.0	1.0	0.5
Min. Height (mV)	0.0	0.0	0.0
Min. Area (mV S)	0.0	0.0	0.0
Filter Level	2	2	4
Integration Delay (S)	150	120	100

Automatic integration should be disabled for all three compounds. Automatic integration provides maximum sensitivity for a given noise level, assuming a very flat baseline. These parameters work well for quantitation of relatively large peaks, but not so well for trace measurements due to baseline effects becoming a greater factor in the determination of the integration settings.

Column A Method for Styrene

Figure 35 is a typical chromatography for styrene on Column A and Figure 36 shows the separation obtained from interference compounds that may be present.

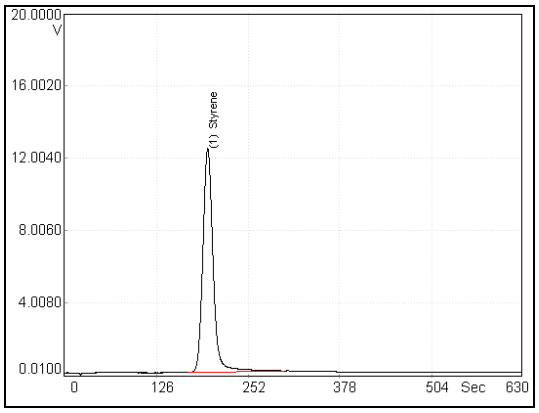


Figure 35 Styrene - 25 ppm

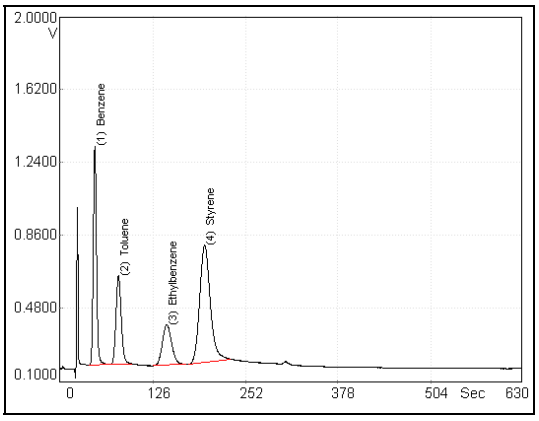


Figure 36 Styrene and Possible Interference Compounds

Column B Method for Acrylonitrile

Figure 37 shows typical chromatography for acrylonitrile. It is analyzed on Column B. As you can see, Voyager is not very sensitive to acrylonitrile.

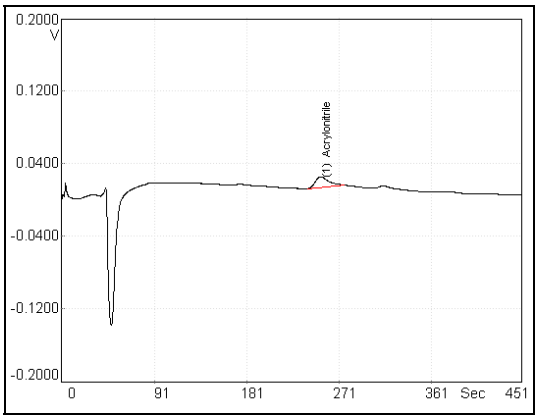


Figure 37 Acrylonitrile - 2 ppm

The pronounced tailing of the peak makes it difficult to obtain good integration of acrylonitrile, especially at concentrations less than 2 ppm. You should manually verify the integration for this compound whenever an accurate concentration is required.

If you are analyzing acrylonitrile at TLV, then calibrate using a standard at the TLV concentration. If integration is questionable, then the peak should be re-integrated in such a way as to over estimate the concentration rather than under estimate it.

Column C Method for 1,3-Butadiene

Figure 38 illustrates typical chromatography for 1,3-butadiene on Column C. On this column 1,3-butadiene can be separated from the butenes, which are often found in the same environment, as shown in Figure 39.

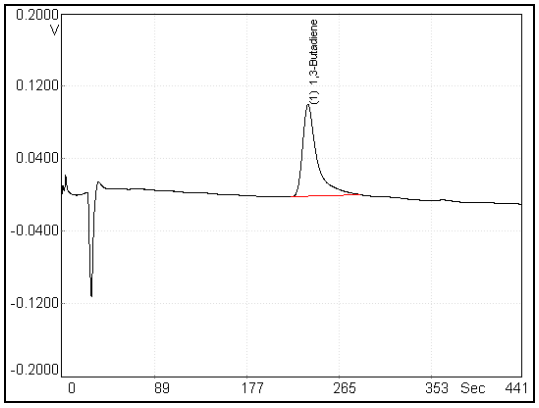


Figure 38 1,3-Butadiene - 1 ppm

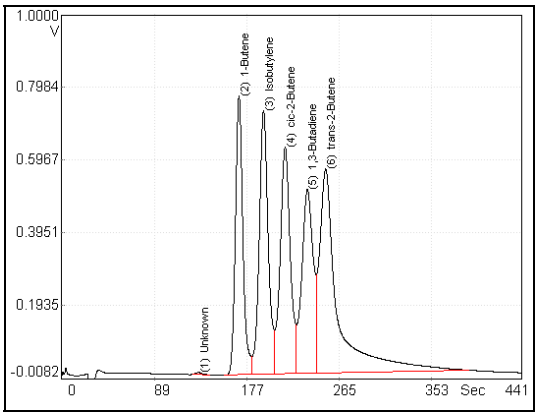


Figure 39 1,3-Butadiene and C4 Interferences

Column Specifications

Column A	
Length	2.5 meters (m)
Internal Diameter	0.53 millimeters (mm)
Coating Thickness	2 micrometers (um)
Coating/Packing Material	35% phenyl, 65% methyl phase capillary column (SPB-35)
Column V (TVOC)	
Length	8 m
Internal Diameter	0.25 mm
Coating Thickness	N/A
Coating/Packing Material	blank (deactivated)
Column B	
Length	20 m
Internal Diameter	0.32 mm
Coating Thickness	1.5 um
Coating/Packing Material	WAX phase capillary column (Supelcowax 10™)
Column C	
Length	4’ x 1/16”
Internal Diameter	0.040”
Coating Thickness	N/A
Coating/Packing Material	1% SP-1000 on 60/80 Carbopack® B (SPB-1)

Accurate Concentration Measurement

The following information is provided to assist you in understanding some of the analytical issues regarding the analysis of acrylonitrile, 1,3-butadiene and styrene (ABS) in ambient air.

When you are detecting compound concentrations in air samples using gas chromatography, it is important to recognize that there are various potential sources of error in the measurements. These sources of error combine to give scatter in measured concentrations (measured as precision) and systematic bias to measured concentrations. You must correct for these sources of error or your results will become inaccurate.

Possible sources of error include:

- Peak integration errors.
- Sampling errors.
- Compound dependent adsorption effects.
- Detector response drift over the period of time since the last calibration.
- System accuracy.

All of these effects may contribute to inaccurate measurements in any given set of data.

Peak Integration Errors

Baseline noise, interfering peaks or excessive tailing of the target compound peak can cause problems in starting or stopping the peak integration at the optimum times. These can even cause differences in integration for consecutive runs at the same concentration. Selection of one set of integration parameters over another may result in a nonlinear area versus concentration curve.

It is impossible to completely eliminate integrator effects as a source of error over the broad range of conditions under which Voyager must operate. For this reason, it is essential that you verify the integration results by examining the chromatograms and re-integrating, if necessary. This is particularly true if the results are being used to make decisions regarding health and safety issues.

Sampling Errors

Sampling errors occur when the concentration of a compound in the gas sample presented to the analytical system is not the same as the original sample.

For example: A Tedlar® bag is filled with styrene and sampled at regular intervals. A graph of measured concentration versus time produces a curve as shown in Figure 25. This measurement sequence lasted for about 8 hours. The last run was performed approximately 8 hours after the initial sequence of runs had been completed. This data trend is symptomatic of adsorption of styrene by the gas bag.

If the same concentration of styrene is measured directly from a tank of compressed gas, standard drift effects over the same time period are negligible. If a Tedlar bag is used to store a styrene sample at these concentrations, then the analysis results hours later will not accurately reflect the concentration at the time of sampling.

In addition to container effects, there are a variety of other issues regarding sample storage, processing and preparation that can compromise the accuracy of the concentration measurement.

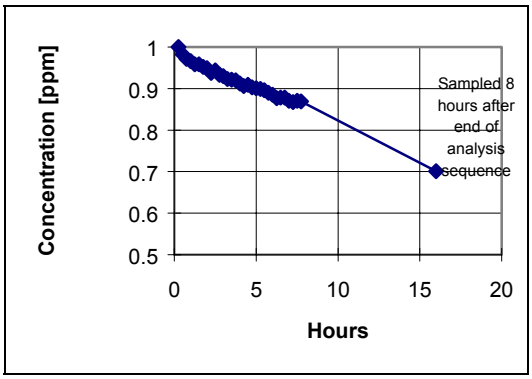


Figure 40 Gas Bag Effect as Measured on a 1 ppm Styrene Sample

Adsorption

Another potential instrument source of error is sample adsorption by Voyager's analytical system. If this occurs, it will typically be seen as an increase in peak area upon repeated sampling of the component, even after the instrument has been in operation for many hours. The effect is usually concentration dependent as higher concentrations will supply the demand of a limited number of adsorption sites without a significant percentage of sample loss.

Voyager has been designed to minimize adsorption effects by heating the analytical system. However some compounds may still be problematic at low concentrations. Each target compound has been tested for adsorption effects and the results are illustrated below. These results were used to generate the precision specifications for ABS.

Acrylonitrile

To test Voyager for an adsorption effect with acrylonitrile, an instrument which had been allowed to stabilize for several hours and which had not recently been exposed to acrylonitrile was set up to make consecutive measurements on a 2.1 ppm sample and then consecutive measurements of a 9.9 ppm sample.

The analysis time for each run was approximately 15 minutes. Each test took 3 hours.

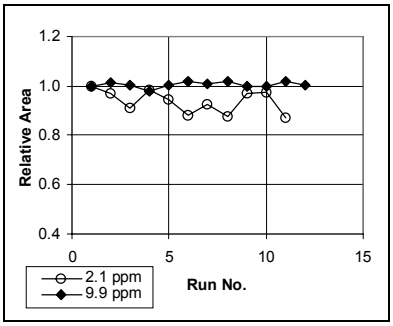


Figure 41 Peak Area Stability for Acrylonitrile

Figure 41 shows the peak area stability obtained during these tests. The precision obtained in these run sequences was 5% for the 2.1 ppm sample and 1.2% for the 9.9 ppm sample. Neither graph indicates adsorption. Poor precision at the lower concentration is caused by the poor peak shape at a low signal level. This leads to more random error in the integrated area.

1,3-Butadiene

Figure 42 shows results obtained for repetitive sampling of 1,3-butadiene with a 5 second inject at concentrations of 0.7 ppm and 5 ppm. Sample concentrations were prepared by dilution of a high concentration standard in a tank with zero grade air. The instruments were allowed to stabilize for several hours and had not recently been exposed to 1,3-butadiene. These runs were performed consecutively with no delay between analyses.

The concentration trend seen at 0.7 ppm is characteristic of system adsorption or conditioning phenomena. At 0.7 ppm, the overall peak area drift over a sequence of more than 20 runs is approximately 10%. At 5 ppm there is no discernible trend to the data.

These results suggest that under these conditions at low concentrations of 1,3-butadiene (1 ppm or less) the quantitation error may be 10%, although sample-to-sample precision would be quite good.

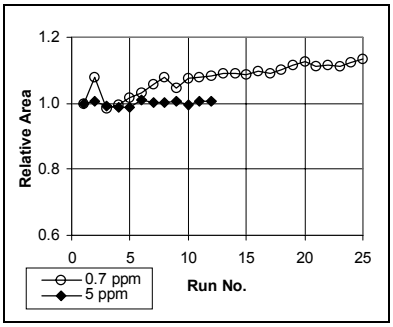


Figure 42 Peak Area Stability for 1,3-Butadiene

Styrene

To test for concentration measurement errors caused by adsorption of styrene, samples were prepared at 0.9 ppm and 6.3 ppm in air by blending a high concentration standard with zero grade air. These low concentration mixes were analyzed with instruments which had been warming up for several hours and had not recently been exposed to styrene. Each concentration was repetitively sampled and analyzed over a period of 3 hours in the case of the 6.3 ppm sample and 8 hours in the case of the 0.9 ppm sample. A run was done approximately every 15 minutes.

Figure 43 shows the peak area stability obtained in these tests. The precision obtained over both of these run sequences was better than 1% (as % relative standard deviation). There are no signs of adsorption effects.

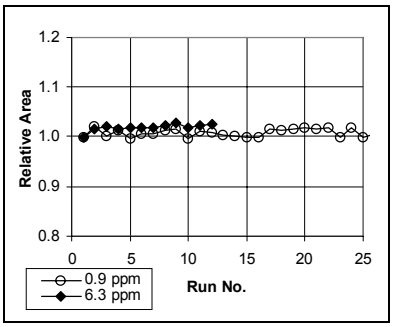


Figure 43 Peak Area Stability for Styrene

Detector Response Drift

Detector response drift is caused by drift in the effective UV lamp intensity over time. Although Voyager automatically maintains a constant visible lamp intensity, it is possible that the ionizing spectral lines, located outside the visible range, shift in intensity over time.

Detector response drift will manifest itself as an effect which typically occurs over a longer time period than adsorption and which is not as compound specific as adsorption. Also, it is not affected by the frequency of sampling, unlike adsorption phenomena. Calibration is recommended when the detector response has changed by greater than 10%.

The table below provides recommended maximum operating time before calibration is necessary. Voyager must be calibrated when it is turned on and should be calibrated at the indicated interval thereafter. We recommend that you perform the calibration under similar temperature and humidity conditions as that of the sample.

The calibration information in the table and the discussion that follows are applicable only for measurement of dry, pure, sample gases containing the target compounds at approximately calibration concentrations.

Compound	**TLV (ppm)**	**Precision % RSD From Mean ***	**Calibration Interval (Hrs) ****
Acrylonitrile	2	5% @ 2 ppm	8
1,3-Butadiene	10	0.6% @ 5ppm	8
Styrene	50	0.8%@ 5ppm	8
* Based on five consecutive samples ** Interval between calibrations for <10% change in accuracy assuming Voyager is calibrated once immediately after a 20 minute warm up period.			

These calibration times are based on an extended measurement of peak area drift following instrument warm-up. A Voyager which has been off for an extended period is turned on and set to auto sample and analyze isobutylene on Column B. Isobutylene is a volatile compound and so typically does not show adsorption effects. The observed peak area drift is an indication of detector drift only.

The resulting area drift over a period of 400 minutes is shown in Figure 44. The change in peak area over this time period was 5%.

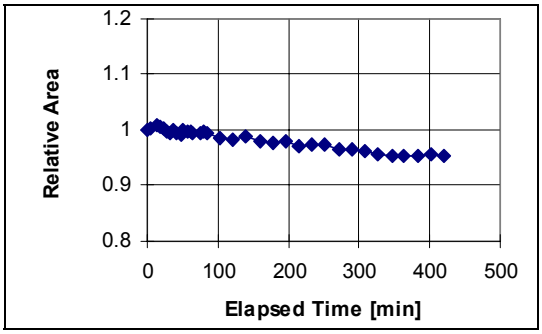


Figure 44 Peak Area Stability for Repetitive Sampling for 100 ppm Isobutylene

This drift characteristic is typical of Voyager's detector response drift following a 20 minute warm-up period. To ensure a measured concentration (at the calibration concentration) is within 10% of the actual value:

1. Calibrate once when the instrument is turned on.

   Allow 30 minutes for the instrument to stabilize before performing the calibration run(s)

2. Calibrate at 8 hour intervals.

Assuming detector response drift is similar for the ABS compounds, you need to calibrate once, immediately following instrument warm-up. Measurement of dry, pure samples at a similar concentration to the calibration concentration should then give a result accurate to within 10% for an 8 hour working period.

The intervals listed in the table are meant as a guideline. It is possible the instrument may drift more or less rapidly in practice. This will depend on your application and operating conditions. You may need to calibrate more frequently to ensure reliable results.

As a measuring instrument, Voyager has a non-linear response for many compounds. Therefore, in order to make accurate measurements at concentrations other than the calibration concentration it is necessary to correct for instrument non-linearity.

This can only be done if a multiple point calibration is performed to determine the response of the instrument over the concentration range. If the response curve characteristics are measured in this way, then reasonably accurate measurements can be made.

Assay 5 User Notes 11

An Overview of Assay 5

Assay 5 consists of 9 compounds from the pulp and paper process. Voyager has been configured to separate and resolve as many of these target compounds as possible. With the standard method ethyl mercaptan and dimethyl sulfide may co-elute.

Assay 5 is composed of six methods. Your instrument can be set up for any one of these methods. If your requirements change, you can load another method from the assay disk. Select the method that is appropriate for your application and use it to perform your analyses. The six methods included in Assay 5 have been designed to cover most of the applications of the pulp and paper process. The standard method (5A) will be installed in your Voyager. The table below provides a list of possible applications and the associated method for each application.

Application	Method	Comments
All compounds: α-Pinene, Methyl Mercaptan, Ethyl Mercaptan, Dimethyl Sulfide, Methanol, Acetone, MEK, Dimethyl Disulfide, Hydrogen Sulfide	5A	Low concentration range
All compounds except α-Pinene	5B	Low concentration range
Hydrogen Sulfide	5C	Low concentration range
Sulfur Gases: Methyl Mercaptan, Ethyl Mercaptan, Dimethyl Sulfide, Dimethyl Disulfide, Hydrogen Sulfide	5D	High concentration range
Hydrogen Sulfide	5E	High concentration range
Solvents: Acetone, Methyl Ethyl Ketone	5F	High/TLV concentration range

NOTE: *If your application is not covered by one of these methods, you can use SiteChart to customize the method for your application.*

The Assay 5 Disk

Two types of files are included on the assay disks. Application (or method) files have the extension .app. Method files are loaded through the Assay tab in SiteChart and are used to program Voyager. Assay5A.app is the standard method. Assay5B.app to Assay5F.app are versions of the standard method that have been modified to analyze different sets of compounds and different concentration ranges.

- Assay5A.app
- Assay5B.app
- Assay5C.app
- Assay5A.pid
- Assay5B1.pid
- Assay5B2.pid
- Assay5B3.pid
- Assay5B4.pid
- Assay5C.pid
- Assay5D.app
- Assay5E.app
- Assay5F.app

Chromatograms from the photoionization detector are identified as .pid files. The supplied chromatograms were generated on your instrument, using the standard method.

➢ Make a copy of all the files on the assay disk and use this as your working disk. Store the original disk in a safe location.

Installation

1. Copy the files onto the PC as described in *Installing your Assay Disk* on page 106.

2. Load the assay into Voyager as described in *Loading an Assay into Voyager* on page 109.

Compound Separation

Separation of the 9 compounds is accomplished in three separate runs in which the heavy, mid-range, and light compounds of the sample are directed to the appropriate column for analysis.

The heavy compound, α-pinene, is analyzed on Column A. Any lighter compounds present in the sample are not well separated and elute as early peaks. The integration delay can be used to prevent these peaks from being included in the peak report. See Figure 45.

The mid-range compounds (e.g. dimethyl sulfide, methyl mercaptan) are analyzed on Column B. Column A is used as the precolumn. The sample is injected onto Column A and the heavy compounds are prevented from entering Column B by adjusting the backflush time. The light and mid-range compounds are allowed to pass from Column A to Column B. Before the heavy compounds are able to pass into Column B, the flow is reversed, and the heavy compounds are backflushed out of Column A.

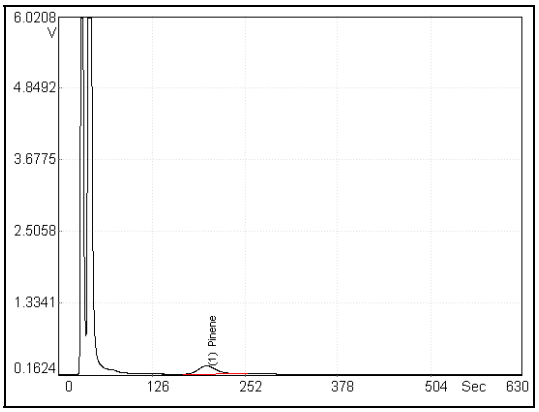


Figure 45 Run on Column A

Some separation of compounds occurs on Column A, with the majority of the separation occurring on Column B. Any light compounds present in the sample are not separated and elute as early peaks, well separated from the Column B compounds. The integration delay can be used to prevent these peaks from being included in the peak report, as shown in Figure 46.

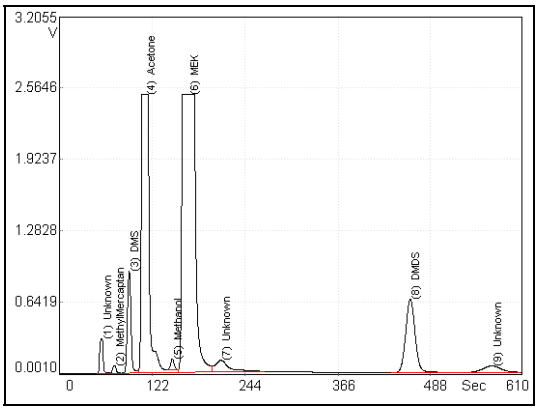


Figure 46 Run on Column B

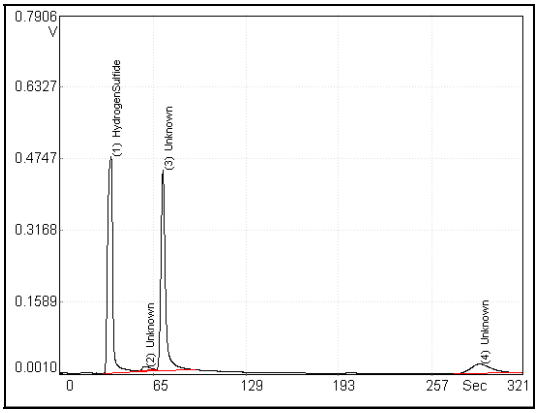


Figure 47 Run on Column C

The light compound, hydrogen sulfide, is analyzed on Column C. Column A is used as the precolumn. As before, the mid-range and heavy compounds are prevented from entering Column C by adjusting the backflush time. In this case only the light compounds are allowed to pass from Column A to Column C. All other compounds are backflushed out of the system. No real separation of the light compounds occurs on Column A. All the separation occurs on Column C.

Co-elution

In this assay, a co-elution exists in the Column B run. Ethyl mercaptan and dimethyl sulfide are typically 5 seconds apart. Assay Wizard will prompt you to select one of these compounds to be included in the assay. If only one of these compounds is present in your sample, SiteChart's Assay Wizard will allow you to select the compound of interest and advise you that the other compound may be an interference. If you require both compounds for your application, you must identify and quantify them as a co-elution.

Compound Library

Assay Compounds

Installed in Voyager, there are three standard compound libraries—one for each column. The libraries contain retention time and response information for each of the assay compounds. These libraries have been determined for all of the Assay 5 methods. If a method is altered, these libraries are no longer valid. If the method is modified, a new library must be created, identifying the compounds with their new retention times.

For example, if the temperature of Column B is increased, retention times in the Column B library are no longer valid, since compounds will be eluting faster than they would in the standard method. You would have to run the compounds with the new settings and store all of the compounds in the library.

Interference Compounds

The compounds listed in the table below are possible interference compounds. These compounds are not part of Assay 5, but may be present in your application. If you need to add these or any other compounds to one of the assay methods, you must add the compounds to the library, identify them as calibration compounds and calibrate your instrument.

Isopropyl alcohol and methylene chloride co-elute with MEK on Column B. Methane and ethane co-elute with hydrogen sulfide on Column C. These compounds cannot be separated using the methods supplied with Assay 5. If you need to separate the target compounds from these interferences, contact the PerkinElmer Photovac applications group.

The PID is not very responsive to methane and ethane. However, it is approximately 100 times more sensitive to hydrogen sulfide than it is to methane and ethane. You may be able to use this information to quantify hydrogen sulfide in the presence of low concentrations of ethane and methane.

If any of these interference compounds are present, you may want to modify some chromatographic settings to ensure the best possible separation and peak identification.

Column B	**R.T. (min)**	**R.T. (S)**
Isopropyl Alcohol	3.6	215
Methylene Chloride	3.8	227
Column C		
Methane\Ethane Co-elution	0.6	35
Propane	1.08	65
Butane	3.47	208

NOTE: *The information in the table is for reference only. Actual retention times may vary significantly.*

Compound Names

Compound names are limited to 15 characters in the Voyager library. Some compound names have been shortened to fit into the Library. The list below shows the shortened compound name.

Compound Name	Voyager Library Name
α-Pinene	Pinene
Methyl Mercaptan	MethylMercaptan
Dimethyl Sulfide	DMS
Methyl Ethyl Ketone	MEK
Dimethyl Disulfide	DMDS
Hydrogen Sulfide	HydrogenSulfide

Method 5A - All Compounds

The standard method (5A) includes all of the Assay 5 compounds. If you are using this method and you need to analyze all of these compounds, you must perform 3 runs, one on each column, to calibrate the instrument and 3 runs to complete an analysis.

The table below lists the compounds and the typical concentration ranges for this method. Concentrations outside the specified ranges, especially at the lower end, can be obtained by adjusting the injection time, PID state and integration parameters.

Whenever accurate concentration readings are required, you should integrate peaks manually and verify the integration.

Column A	**R.T. (S)**	**Concentration Range (ppm)**	**Co-elution**
α-Pinene	197	10-150	No
Column B			
Methyl Mercaptan	80	0.05-10	No
Ethyl Mercaptan	98	0.05-10	Yes
Dimethyl Sulfide	103	0.05-10	Yes
Acetone	140	0.1-10	No
Methanol	174	20-500	No
Methyl Ethyl Ketone	218	0.1-5	No
Dimethyl Disulfide	544	0.05-10	No
Column C			
Hydrogen Sulfide	32	0.1-35	No

NOTE: *The information in the table is for reference only. Retention times may vary significantly.*

In this analysis, a co-elution exists in the Column B run. Ethyl mercaptan and dimethyl sulfide are typically 5 seconds apart. Assay Wizard will prompt you to select one of these compounds to be included in the assay.

These parameters may vary between individual instruments:

	Column A	**Column B**	**Column C**
Method			
Carrier Gas	Air	Air	Air
Detector	PID	PID	PID
Analysis Time (S)	660	600	320
Oven Temperature (°C)	60	60	60
Pressure (psi)	12	12	12
PID State	Low Sensitivity	High Sensitivity	High Sensitivity
Injection Method			
Inject Method	Loop Injection	Loop Injection	Loop Injection
Inject Time (S)	0.8	5	5
Pump Time (S)	20	20	20
Backflush Time (S)	300	120	20
Integration Method			
Auto. Integration	Disabled	Disabled	Disabled
Slope Up (mV/S)	1.0	1.0	1.0
Slope Down (mV/S)	1.0	1.0	1.0
Min. Height (mV)	0.0	0.0	0.0
Min. Area (mV S)	0.0	0	0
Filter Level	2	3	3
Integration Delay (S)	130	40	20

Method 5B

The second method is applicable to the sulfur gases and solvents. Column A is not required for this method. If you are using this method and you need to analyze all of these compounds, you must perform 2 runs, one on each column, to calibrate the instrument and 2 runs to complete an analysis.

The table below lists the compounds and the typical concentration ranges for this method. Concentrations outside the specified ranges, especially at the lower end, can be obtained by adjusting the injection time, PID state and integration parameters.

Whenever accurate concentration readings are required, you should integrate peaks manually and verify the integration.

Column B	**R.T. (S)**	**Concentration Range (ppm)**	**Co-elution**
Methyl Mercaptan	80	0.05-10	No
Ethyl Mercaptan	98	0.05-10	Yes
Dimethyl Sulfide	103	0.05-10	Yes
Acetone	140	0.1-10	No
Methanol	174	20-500	No
Methyl Ethyl Ketone	218	0.1-5	No
Dimethyl Disulfide	544	0.05-10	No
Column C			
Hydrogen Sulfide	32	0.1-35	No

Ethyl mercaptan and dimethyl sulfide may co-elute. Assay Wizard will prompt you to select one of these compounds to be included in the assay.

The method parameters for method 5B are shown below. These parameters may vary between individual instruments.

	Column B	**Column C**
Method		
Carrier Gas	Air	Air
Detector	PID	PID
Analysis Time (S)	600	320
Oven Temperature (°C)	60	60
Pressure (psi)	12	12
PID State	High Sensitivity	High Sensitivity
Injection Method		
Inject Method	Loop Injection	Loop Injection
Inject Time (S)	5	5
Pump Time (S)	20	20
Backflush Time (S)	120	20
Integration Method		
Automatic Integration	Disabled	Disabled
Slope Up (mV/S)	1.0	1.0
Slope Down (mV/S)	1.0	1.0
Min. Height (mV)	0.0	0.0
Min. Area (mV S)	0	0
Filter Level	3	3
Integration Delay (S)	40	20

Method 5C and Method 5E

In method 5C, hydrogen sulfide is the only compound to be detected. Only Column C is used. The detector is set to high sensitivity to detect low concentrations.

Method 5E is for hydrogen sulfide at higher concentrations. A smaller sample volume is injected. The detector remains at high sensitivity.

NOTE: *You must store hydrogen sulfide at two or more concentrations throughout the range to achieve maximum accuracy.*

The table below lists the compounds and the typical concentration ranges for this method. Concentrations outside the specified ranges, especially at the lower end, can be obtained by adjusting the injection time, PID state and integration parameters.

Whenever accurate concentration readings are required, you should integrate peaks manually and verify the integration. You may need to adjust the integration parameters to obtain the full concentration range for method 5E.

	R.T. (S)	Concentration Range (ppm)	Co-elution
Method 5C			
Hydrogen Sulfide	32	0.1-35	No
Method 5E			
Hydrogen Sulfide	32	0.3-100	No

Typical method parameters for method 5C and 5E are shown below. These parameters may vary between individual instruments.

	Method 5C	**Method 5E**
Method		
Carrier Gas	Air	Air
Detector	PID	PID
Analysis Time (S)	320	320
Oven Temperature (°C)	60	60
Pressure (psi)	12	12
PID State	High Sensitivity	High Sensitivity
Injection Method		
Inject Method	Loop Injection	Loop Injection
Inject Time (S)	5	0.8
Pump Time (S)	20	20
Backflush Time (S)	20	20
Integration Method		
Automatic Integration	Disabled	Disabled
Slope Up (mV/S)	1.0	1.0
Slope Down (mV/S)	1.0	1.0
Min. Height (mV)	0.0	0.0
Min. Area (mV S)	0	0
Filter Level	3	3
Integration Delay (S)	20	20

Method 5D

In method 5D, Voyager is configured for high concentrations of the sulfur gases. Small sample volumes are injected. You must store the compounds at two or more concentrations throughout the range to achieve maximum accuracy.

The table below lists the compounds and the typical concentration ranges for this method. Concentrations outside the specified ranges, especially at the lower end, can be obtained by adjusting the injection time, PID state and integration parameters.

Whenever accurate concentration readings are required, you should integrate peaks manually and verify the integration.

	R.T. (S)	Concentration Range (ppm)	Co-elution
Column B			
Methyl Mercaptan	80	0.5-50	No
Ethyl Mercaptan	98	0.5-50	Yes
Dimethyl Sulfide	103	0.5-50	Yes
Dimethyl Disulfide	545	0.5-50	No
Column C			
Hydrogen Sulfide	32	0.3-100	No

Typical method parameters for method 5D are shown below. Values may vary between instruments.

	Column B	**Column C**
Method		
Carrier Gas	Air	Air
Detector	PID	PID
Analysis Time (S)	600	320
Oven Temperature (°C)	60	60
Pressure (psi)	12	12
PID State	High Sensitivity	High Sensitivity
Injection Method		
Inject Method	Loop Injection	Loop Injection
Inject Time (S)	0.3	0.8
Pump Time (S)	20	20
Backflush Time (S)	120	20
Integration Method		
Automatic Integration	Disabled	Disabled
Slope Up (mV/S)	0.3	1.0
Slope Down (mV/S)	0.3	1.0
Min. Height (mV)	0.0	0.0
Min. Area (mV S)	0	0
Filter Level	3	3
Integration Delay (S)	40	20

Method 5F

The last method is used for MEK and acetone at TLV concentrations. You must store the compounds at two or more concentrations throughout the range to achieve maximum accuracy.

The table below lists the compounds and the typical concentration ranges for this method. Concentrations outside the specified ranges, especially at the lower end, can be obtained by adjusting the injection time, PID state and integration parameters.

Whenever accurate concentration readings are required, you should integrate peaks manually and verify the integration.

Column B	R.T. (S)	Concentration Range (ppm)	Co-elution
Acetone	140	0.75-800	No
Methyl Ethyl Ketone	218	2-250	No

Typical method parameters for method 5F are shown below. These parameters may vary between individual instruments.

	Column B
Method	
Carrier Gas	Air
Detector	PID
Analysis Time (S)	600
Oven Temperature (°C)	60
Pressure (psi)	12
PID State	Low Sensitivity
Injection Method	
Inject Method	Loop Injection
Inject Time (S)	1
Pump Time (S)	20
Backflush Time (S)	120
Integration Method	
Automatic Integration	Disabled
Slope Up (mV/S)	1.0
Slope Down (mV/S)	*1.0*
Min. Height (mV)	0.0
Min. Area (mV S)	0
Filter Level	3
Integration Delay (S)	40

Creating a Custom Method

You can use the information provided in this document to select your compounds and then optimize the chromatography for your compounds.

There are two ways of creating a custom method. You can modify the library of an existing method. Alternatively, you can optimize the chromatography of an existing method, by changing the method parameters.

General Information

Modifying the library of an existing method is a matter of adding or deleting a compound, performing a calibration and storing the compounds in a custom application file.

Changing the method parameters allows you to create a customized method optimized for your application. However, you must first perform a few analyses to determine the new method's analysis and backflush times.

NOTE: *Do not inject heavy compounds onto Column C. They may be retained for extended periods of time, and may contaminate your column.*

1. Set the Column A backflush time to 1500 seconds and the analysis time to 3200 seconds, then analyze your target compounds on Column A.

   Column A is the precolumn for all other columns, so the retention time of the target compounds on Column A is used to determine the backflush timing the other columns

2. The backflush time for a run on Column B or C is the retention time, from Column A, of the last peak you wish to analyze plus 0 to 50 seconds.

   The backflush time for Column A is equal to the retention time of the last peak of interest plus 50 to 200 seconds, typically.

3. Column A analysis time is equal to 2.2 times the Column A backflush time.

   Because Column A is also the precolumn, it must be backflushed for at least as long as it was foreflushed.

4. Column B and C analysis times must meet two criteria; each must be long enough to permit the last target peak to clear the column, and analysis time must also be a minimum of 2.2 times the backflush time, for any given column.

   If an analysis time is too short, for either of the above reasons, peaks may elute during a later analysis.

NOTE: *Voyager's maximum analysis time is 3200 seconds. If a peak elutes after this time on any column, the method must be modified. Increasing the temperature or pressure will speed up heavy compounds.*

5. Store all target compounds in the library, and calibrate on them using the new method.

Concentration Ranges

The concentrations ranges listed throughout these user notes are typical ranges for which Voyager will identify and quantify the target compounds. Concentrations outside the specified ranges may be detected by adjusting the integration parameters.

For example, at low concentrations, the tail on the α-pinene peak, may require manual integration. You should integrate this peak manually and verify the integration whenever accurate concentration readings are required.

The concentration range specified for a method can also be changed by modifying the injection time or the PID state. The detection range for method compounds will change so you must re-calibrate all library compounds.

The table below summarizes compound information for the existing methods.

	R.T. (S)	Concentration Range (ppm)**	Method
Column A			
α-pinene	197	10-150	5A
Column B			
Methyl Mercaptan	80	0.05-10 0.5-50	5A, B 5D
Ethyl Mercaptan*	98	0.05-10 0.5-50	5A, B 5D
Dimethyl Sulfide*	103	0.05-10 0.5-50	5A, B 5D
Acetone	140	0.75-800 0.1-10	5F 5A, B
Methanol	174	20-250	5A, B
Methyl Ethyl Ketone	218	2-250 0.1-5	5F 5A, B
Dimethyl Disulfide	544	0.05-15 0.5-50	5A, B 5D
Column C			
Hydrogen sulfide	32	0.1-35 0.3-100	5A, B, C 5D, E
** Ethyl mercaptan, dimethyl sulfide will co-elute* *** Concentration ranges are method dependant.*			

NOTE: *The information provided in this table is for guidance purposes only. Exact retention time and concentration range data is specific to your instrument.*

Modifying the Method

If you want to analyze a group of compounds that are a subset of an existing method, then you can modify the method parameters to obtain the desired results. You must make the necessary changes and then save the new method. A few common examples are listed below, use the information in the table as a guide, it is easier to start with an existing method and modify it as necessary.

Compounds of Interest	Start with Method	Comments
α-Pinene	5A	Disable Columns B and C.
Dimethyl Sulfide, Dimethyl Disulfide	5B or 5D	Modify 5B for low concentration range. Remove unused compounds from the Column B library. Modify 5D for high concentration range.
Methyl Mercaptan, Ethyl Mercaptan	5B or 5D	Modify 5B for low concentration range. Remove unused compounds from the Column B library. Modify 5D for high concentration range.
Methyl Mercaptan, Ethyl Mercaptan, Dimethyl Sulfide, Dimethyl Disulfide	5B or 5D	Modify 5B for low concentration range. Remove methanol from the Column B library. Disable Column C. Modify 5D for high concentration range. Disable Column C.
Acetone	5F	Remove methanol and MEK from the Column B library
Methyl Ethyl Ketone	5F	Remove methanol and acetone from the Column B library.

Once the compounds in the library have been determined and the chromatography has been optimized, adjust the analysis time to obtain the shortest cycle time.

Column Specifications

Column A	
Length	2.5 meters (m)
Internal Diameter	0.53 millimeters (mm)
Coating Thickness	2 micrometers (um)
Coating/Packing Material	35% phenyl, 65% methyl phase capillary column (SPB-35)
Column V (TVOC)	
Length	8 m
Internal Diameter	0.25 mm
Coating Thickness	N/A
Coating/Packing Material	blank (deactivated)
Column B	
Length	20 m
Internal Diameter	0.32 mm
Coating Thickness	1.5 um
Coating/Packing Material	WAX phase capillary column (Supelcowax 10™)
Column C	
Length	4' x 1/16"
Internal Diameter	0.040"
Coating Thickness	N/A
Coating/Packing Material	1% SP-1000 on 60/80 Carbopack® B (SPB-1)

Accurate Concentration Measurement

The following information is provided to assist you in understanding some of the analytical issues regarding the analysis of pulp and paper target compounds in ambient air.

When you are detecting compound concentrations in air samples using gas chromatography, it is important to recognize that there are various potential sources of error in the measurements. These sources of error combine to give scatter in measured concentrations (measured as precision) and systematic bias to measured concentrations. You must correct for these sources of error or your results will become inaccurate.

Possible sources of error include:

- Peak integration errors.
- Sampling errors.
- Compound dependent adsorption effects.
- Detector response drift over the period of time since the last calibration.
- System accuracy.

All of these effects may contribute to inaccurate measurements in any given set of data.

Peak Integration Errors

Baseline noise, interfering peaks or excessive tailing of the target compound peak can cause problems in starting or stopping the peak integration at the optimum times. These can even cause differences in integration for consecutive runs at the same concentration. Selection of one set of integration parameters over another may result in a nonlinear area versus concentration curve.

It is impossible to completely eliminate integrator effects as a source of error over the broad range of conditions under which Voyager must operate. For this reason, it is essential that you verify the integration results by examining the chromatograms and re-integrating, if necessary. This is particularly true if the results are being used to make decisions regarding health and safety issues.

Sampling Errors

Sampling errors occur when the concentration of a compound in the gas sample presented to the analytical system is not the same as the original sample.

For example, a Tedlar® bag is filled with styrene and sampled at regular intervals. A graph of measured concentration versus time produces a curve as shown in Figure 48. This measurement sequence lasted for about 8 hours. The last run was performed approximately 8 hours after the initial sequence of runs had been completed. This data trend is symptomatic of adsorption of styrene by the gas bag.

If the same concentration of styrene is measured directly from a tank of compressed gas, standard drift effects over the same time period are negligible. If a Tedlar bag is used to store a styrene sample at this concentration, then the analysis results hours later will not accurately reflect the concentration at the time of sampling.

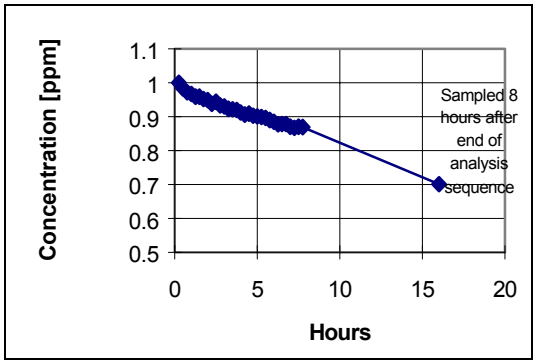


Figure 48 Gas Bag Effect as Measured on a 1 ppm Styrene Sample

In addition to container effects, there are a variety of other issues regarding sample storage, processing and preparation which can compromise the accuracy of the concentration measurement.

Adsorption

Another potential instrument source of error is sample adsorption by Voyager's analytical system. If this occurs, it will typically be seen as an increase in peak area upon repeated sampling of the component, even after the instrument has been in operation for many hours. The effect is usually concentration dependent as higher concentrations will supply the demand of a limited number of adsorption sites without a significant percentage of sample loss.

Voyager has been designed to minimize adsorption effects by heating the analytical system. However some compounds may still be problematic at low concentrations. Each compound has been tested for adsorption effects and typical results are illustrated in following figures. These results were used to generate the precision specifications shown previously.

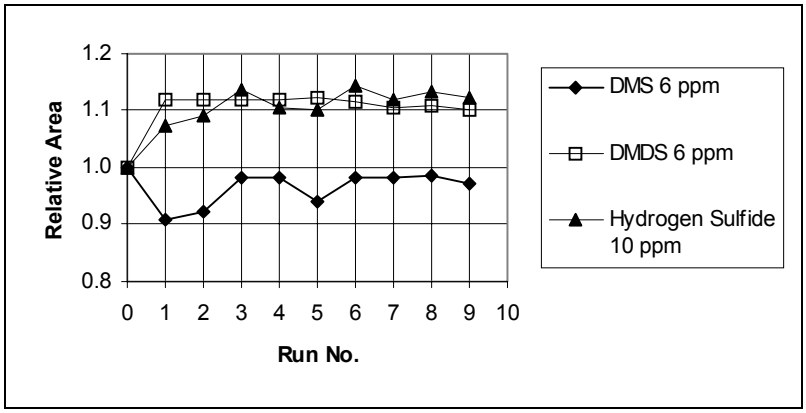


Figure 49 Peak Area Stability for Repetitive Sampling of 6 ppm DMS, 6 ppm DMDS and 10 ppm Hydrogen Sulfide

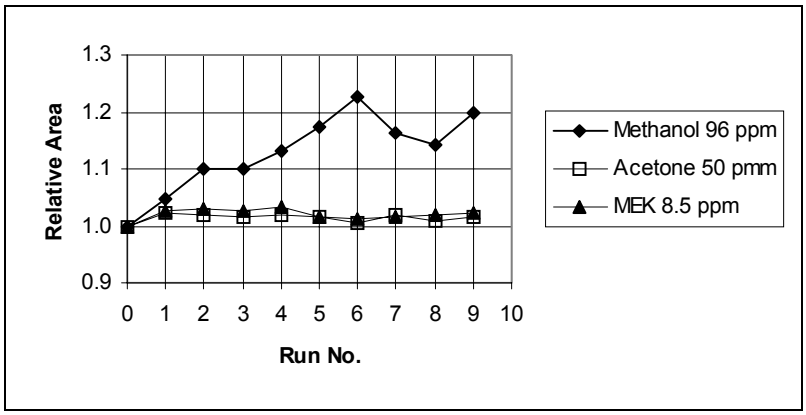


Figure 50 Peak Area Stability for Repetitive Sampling of 96 ppm Methanol, 50 ppm Acetone and 8.5 ppm MEK

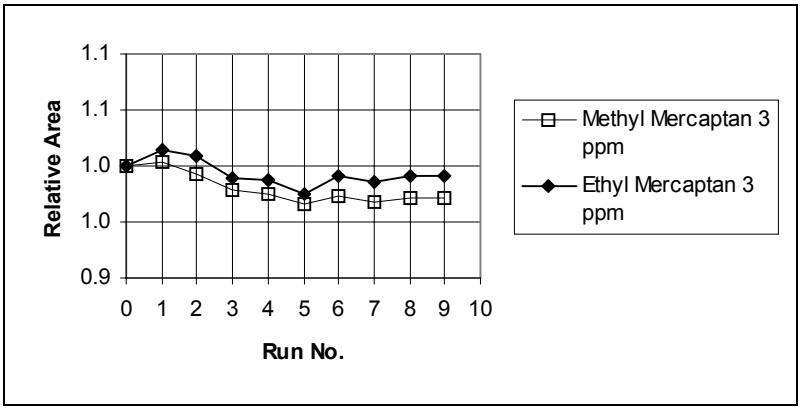


Figure 51 Peak Area Stability for Repetitive Sampling of 3 ppm Methyl Mercaptan and 3 ppm Ethyl Mercaptan

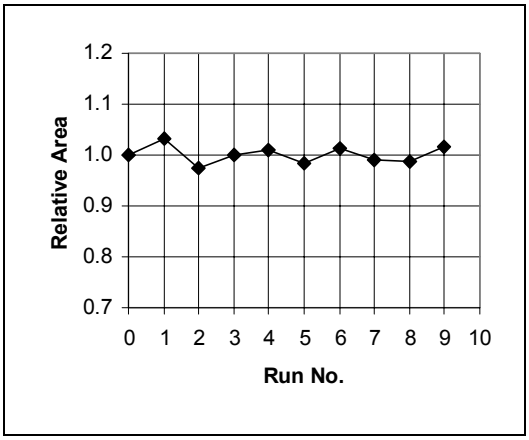


Figure 52 Peak Area Stability for Repetitive Sampling of 11 ppm α-Pinene

The instrument being tested had not previously been exposed to the target compound. The analyses were performed with typical Assay 5 method parameters.

The adsorption test itself consists of repetitive sampling (10 runs) and analysis of the indicated compound concentration. The sample is typically obtained either directly from a tank standard or by diluting a tank standard with air to obtain the indicated concentration. The instrument was calibrated and then the 10 runs were performed.

Test results below, are shown for two compounds as run on one instrument, but are typical for Voyager.

Detector Response Drift

Detector response drift is caused by drift in the effective UV lamp intensity over time. Although Voyager automatically maintains a constant visible lamp intensity, it is possible that the ionizing spectral lines, located outside the visible range, shift in intensity over time.

Detector response drift will manifest itself as an effect that typically occurs over a longer time period than adsorption and which is not as compound specific as adsorption. Also, it is not affected by the frequency of sampling, unlike adsorption phenomena. Calibration is recommended when the detector response has changed by greater than 10%.

The table below provides a recommended maximum operating time before calibration is necessary. The instrument must be calibrated when Voyager is turned on and should be calibrated at the indicated interval thereafter. We recommend that you perform the calibration under similar temperature and humidity conditions as that of the sample.

The calibration information and the discussion which follows are applicable only for measurement of dry, pure, sample gases containing the target compounds at approximately calibration concentrations.

Compound	**TLV (ppm)**	**Precision % RSD From Mean ****	**Calibration Interval* (Hrs)**
Hydrogen Sulfide	10	4.8@10ppm	8
Methyl Mercaptan	0.5	1.3@3ppm	8
Ethyl Mercaptan	0.5	1.2@3ppm	8
Dimethyl Sulfide		4.2@6ppm	8
Dimethyl Disulfide		4.9@6ppm	8
Methanol	200	4.8@96ppm	8
Acetone	750	0.8@50ppm	8
Methyl Ethyl Ketone	200	1.3@8.5ppm	8
α-Pinene		2@11ppm	8
* Based on five consecutive samples. ** Interval between calibrations for <10% change in accuracy assuming Voyager is calibrated once immediately after a 20 minute warm up period.			

These calibration times are based on an extended measurement of peak area drift of a generic compound (isobutylene) following instrument warm-up. A Voyager which has been off for an extended period is turned on and set to auto sample and analyze isobutylene on Column B. Isobutylene is a volatile compound and so typically does not show adsorption effects. The observed peak area drift is an indication of detector drift only. The resulting area drift over a period of 400 minutes is shown in Figure 53. The change in peak area over this time period was 5%.

This drift characteristic is typical of Voyager's detector response drift, following a 20 minute warm-up period. Although this test is performed with isobutylene. the same approximate, peak area drift can be expected for any of the Assay 5 compounds. To ensure a measured concentration (at the calibration concentration) is within 10% of the actual value:

1. Calibrate once when the instrument is turned on.

   Allow 30 minutes for the instrument to stabilize before performing the calibration run(s).

2. Calibrate at 8 hour intervals.

Assuming detector response drift is similar for the pulp and paper compounds, you need to calibrate once, immediately following instrument warm-up. Measurement of dry, pure samples at a similar concentration to the calibration concentration should then give a result accurate to within 10% for an 8 hour working period.

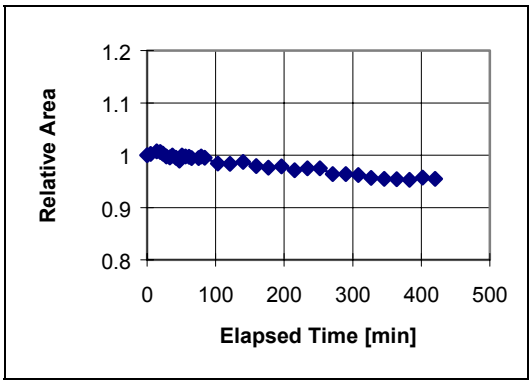


Figure 53 Peak Area Stability for Repetitive Sampling for 100 ppm Isobutylene

Assuming detector response drift is similar for the pulp and paper compounds, you need to calibrate once, immediately following instrument warm-up. Measurement of dry, pure samples at a similar concentration to the calibration concentration should then give a result accurate to within 10% for an 8 hour working period.

The intervals listed in the previous table are meant as a guideline. It is possible the instrument may drift more or less rapidly in practice. This will depend on your application and operating conditions. You may need to calibrate more frequently to ensure reliable results.

As a measuring instrument, Voyager has a non-linear response for many compounds. Therefore, in order to make accurate measurements at concentrations other than the calibration concentration it is necessary to correct for instrument non-linearity.

This can only be done if a multiple point calibration is performed to determine the response of the instrument throughout the concentration range of interest.

If the response curve characteristics are measured in this way, then reasonably accurate measurements can be made.

Assay 6 User Notes 12

An Overview of Assay 6

Assay 6 consists of 2 compounds from the surfactant manufacturing process. Voyager has been configured to separate and resolve these target compounds.

The Assay 6 Disk

Two types of files are included on the assay disks. Application (or method) files have the extension .app. Method files are loaded through the Assay tab in SiteChart and are used to program Voyager. Assay6.app is the standard method. It provides chromatographic settings so that all compounds can be run on a single column.

Chromatograms from the photoionization detector are identified as .pid files. Assay6.pid is a sample chromatogram, from your instrument, of the compounds of interest using the standard method.

- Assay6.app
- Assay6i.pid
- Assay6.pid

➢ Make a copy of all the files on the assay disk and use this as your working disk. Store the original disk in a safe location.

Installation

1. Copy the files onto the PC as described in *Installing your Assay Disk* on page 106.

2. Load the assay into Voyager as described in *Loading an Assay into Voyager* on page 109.

Compound Separation

Separation of ethylene oxide and propylene oxide is accomplished in one run on Column C. Column A is used as the precolumn.

The sample is injected onto Column A. Heavy compounds in the sample are prevented from entering Column C by adjusting the backflush time. Ethylene oxide and propylene oxide are allowed to pass from Column A to Column C. Before the heavy compounds are able to pass into Column C, the flow is reversed, and the heavy compounds are backflushed out of Column A.

The backflush time is set to trim off everything after propylene oxide on Column A, and the analysis time is adjusted to allow for the propylene oxide to elute completely, as shown in Figure 54.

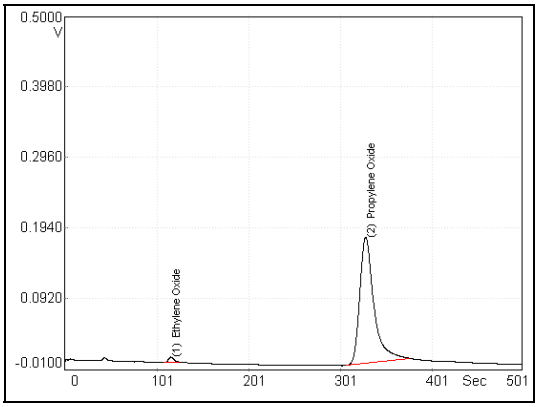


Figure 54 Assay 6 Compounds Run on Column C

Compound Library

Assay Compounds

One standard compound library is installed in Voyager for Column C. The library contains retention time and response information for each assay compound. The library has been determined for the Assay 6 standard method. If the method is altered, the library is no longer valid. If the method is modified, a new library must be created, identifying the compounds with their new retention times.

For example, if the column temperature is increased, the retention time in the Column C library is no longer valid, since compounds will be eluting faster than they would in the standard method. You would have to run the compounds with the new settings and store the compounds in the library.

Interference Compounds

Ethylene and propylene are possible interferences and may be present in your samples.

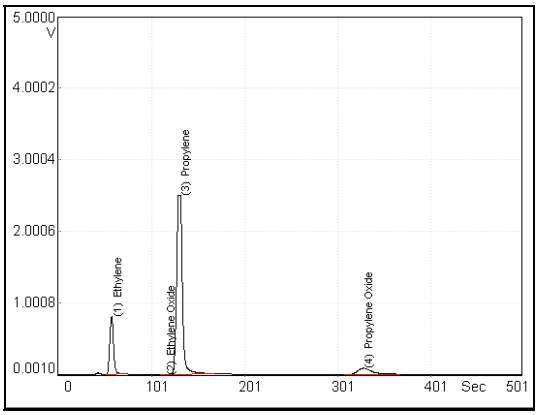


Figure 55 Assay 6 Interference Compounds

If any of these interference compounds are present in your application, you may want to modify some chromatographic settings to ensure the best possible separation and peak identification.

Column C	**R.T. (min)**	**R.T. (S)**
Ethylene	1.0	58
Propylene	2.2	133

Assay 6 Standard Method

Typical method parameters for Assay 6 are shown below. These parameters will vary between instruments.

	Column C
Method	
Carrier Gas	Air
Detector	PID
Analysis Time (S)	500
Oven Temperature (°C)	45
Pressure (psi)	7.5
PID State	High Sensitivity
Injection Method	
Inject Method	Loop Injection
Inject Time (S)	4.0
Pump Time (S)	20
Backflush Time (S)	60
Integration Method	
Automatic Integration	Disabled
Slope Up (mV/S)	0.5
Slope Down (mV/S)	1.0
Min. Height (mV)	0.0
Min. Area (mV S)	0.0
Filter Level	4
Integration Delay (S)	45

All compounds will be stored in the library at one concentration. Ideally each compound will be stored at the TLV level. If this is not possible, the compound will be stored at some concentration appropriate for the application. You should perform multiple point calibrations for most accurate results.

Column C	**R.T. (S)**	**Concentration Range (ppm)**	**Co-elution**
Ethylene oxide	115	0.5 - 10	No
Propylene oxide	328	2 - 200	No

NOTE: *The information in the table above is for reference only. Retention times may vary significantly.*

Concentrations outside the specified range, especially at the lower end, can be obtained by adjusting the injection time, PID state and integration parameters.

To obtain maximum verify the integration whenever accurate concentration readings are required. Re-integrate manually if necessary.

Column Specifications

Column A	
Length	2.5 meters (m)
Internal Diameter	0.53 millimeters (mm)
Coating Thickness	2 micrometers (um)
Coating/Packing Material	35% phenyl, 65% methyl phase capillary column (SPB-35)
Column V (TVOC)	
Length	8 m
Internal Diameter	0.25 mm
Coating Thickness	N/A
Coating Material	blank (deactivated)
Column B	
Length	20 m
Internal Diameter	0.32 mm
Coating Thickness	1.5 um
Coating/Packing Material	WAX phase capillary column (Supelcowax 10™)
Column C	
Length	4’ x 1/16”
Internal Diameter	0.040”
Coating Thickness	N/A
Coating/Packing Material	1% SP-1000 on 60/80 Carbopack® B (SPB-1)

Accurate Concentration Measurement

The following information is provided to assist you in understanding some of the analytical issues regarding the analysis of surfactants in ambient air.

When you are detecting compound concentrations in air samples using gas chromatography, it is important to recognize that there are various potential sources of error in the measurements. These sources of error combine to give scatter in measured concentrations (measured as precision) and systematic bias to measured concentrations. You must correct for these sources of error or your results will become inaccurate.

Possible sources of error include:

- Peak integration errors.
- Sampling errors.
- Compound dependent adsorption effects.
- Detector response drift over the period of time since the last calibration.
- System accuracy.

All of these effects may contribute to inaccurate measurements in any given set of data.

Peak Integration Errors

Baseline noise, interfering peaks or excessive tailing of the target compound peak can cause problems in starting or stopping the peak integration at the optimum times. These can even cause differences in integration for consecutive runs at the same concentration. Selection of one set of integration parameters over another may result in a nonlinear area versus concentration curve.

It is impossible to eliminate integrator effects as a source of error over the broad range of conditions under which Voyager must operate. It is therefore, essential that you verify the Voyager's integration results. Examine the chromatograms and re-integrating, if necessary. This is particularly true if the results are being used to make decisions regarding health and safety issues.

Sampling Errors

Sampling errors occur when the concentration of a compound in the gas sample presented to the analytical system is not the same as the original sample.

For example, a Tedlar® bag is filled with styrene and sampled at regular intervals. A graph of measured concentration versus time produces a curve as shown in Figure 56. This measurement sequence lasted for about 8 hours. The last run was performed approximately 8 hours after the initial sequence of runs had been completed. This data trend is symptomatic of adsorption of styrene by the gas bag.

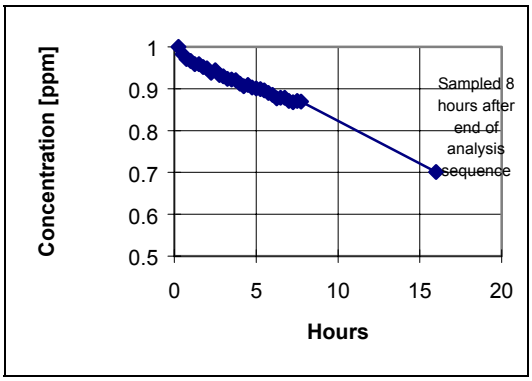


Figure 56 Gas Bag Effect as Measured on a 1 ppm Styrene Sample

If the same concentration of styrene is measured directly from a tank of compressed gas, drift effects over the same time period are negligible. If a Tedlar bag is used to store a styrene sample at this concentration, then the analysis results hours later will not accurately reflect the concentration at the time of sampling.

In addition to container effects, there are a variety of other issues regarding sample storage, processing and preparation, which can compromise the accuracy of the concentration measurement.

Adsorption

Another potential source of error is sample adsorption by Voyager's analytical system. If this occurs, it will typically be seen as an increase in peak area on repeated sampling of the component, even after the instrument has been in operation for many hours. The effect is usually concentration dependent, as higher concentrations will fill a limited number of adsorption sites without a significant percentage of sample loss.

Voyager has been designed to minimize adsorption effects by heating the analytical system. However some compounds may be problematic at low concentrations. Each Assay 6 compound has been tested for adsorption effects and the results are illustrated in Figures 4 and 5. These results were used to generate the precision specifications for Assay 6, below.

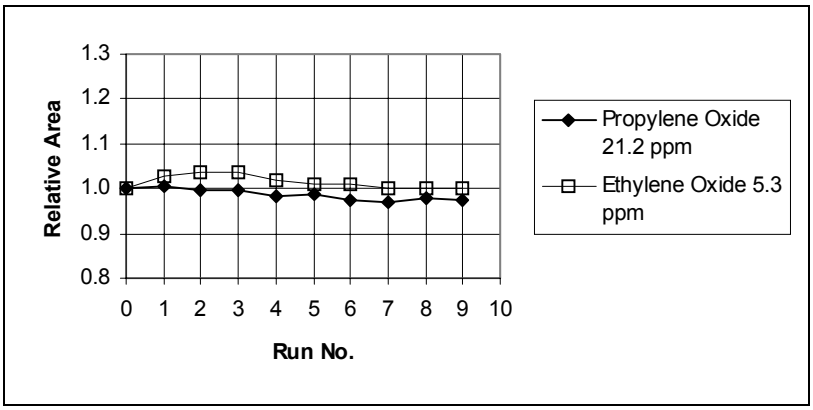


Figure 57 Peak Area Stability for Repetitive Sampling of 21.2 ppm Propylene Oxide and 5.3 ppm Ethylene Oxide

The instruments being tested had not previously been exposed to the target compound. The analyses were performed with typical Assay 6 method parameters. A bag sample is prepared containing all the Assay 6 target compounds at the indicated concentrations.

The adsorption test itself consists of repetitive sampling (10 runs) and analysis of the compound at the indicated concentration. The sample is typically obtained either directly from a tank or by diluting a tank standard with air to obtain the indicated concentration. The instrument was calibrated and then the 10 runs were performed.

The Assay 6 compounds are stable in a gas bag at the indicated concentrations. Test results are shown for each compound as run on one instrument. See Figure 57. These results are typical for Voyager.

Detector Response Drift

Detector response drift is caused by drift in the effective UV lamp intensity over time. Although Voyager maintains a constant visible lamp intensity, it is possible that the ionizing spectral lines, located outside the visible range, shift in intensity over time.

Detector response drift will manifest itself as an effect which typically occurs over a longer time period than adsorption and which is not as compound specific as adsorption. Also, it is not affected by the frequency of sampling, unlike adsorption phenomena. Calibration is recommended when the detector response has changed by greater than 10%.

The table below provides a recommended maximum operating time before calibration is necessary. The instrument must be calibrated when Voyager is turned on and should be calibrated at the indicated interval thereafter. We recommend that you perform the calibration under similar temperature and humidity conditions as that of the sample.

The calibration information in the table and the discussion which follows are applicable only for measurement of dry, pure, sample gases containing the target compounds at approximately calibration concentrations.

Compound	TLV ppm	Precision % RSD* from Mean	Calibration Interval** (Hrs)
Ethylene oxide	1.0	1.5@5 ppm	8
Propylene oxide	20	1.2@20 ppm	8

* Based on five consecutive samples

** Interval between calibrations for <10% change in accuracy assuming Voyager is calibrated once immediately after a 20 minute warm up period.

These calibration times are based on an extended measurement of peak area drift of a generic compound (isobutylene) following instrument warm-up. A Voyager which has been off for an extended period is turned on and set to auto analyze isobutylene on Column B. Isobutylene is a volatile compound. Typically it does not show adsorption effects. The observed peak area drift is an indication of detector drift only. The resulting area drift over a period of 400 minutes is shown in Figure 58. The change in peak area over this time period was 5%.

This drift characteristic is typical of Voyager's detector response drift, following a 20 minute warm-up period. Although this test is performed with isobutylene, the same, approximate peak area drift can be expected for any of the Assay 6 compounds. To ensure a measured concentration (at the calibration concentration) is within 10% of the actual value:

1. Calibrate once when the instrument is turned on.

   Allow 30 minutes for the instrument to stabilize before performing the calibration run(s).

2. Calibrate at 8 hour intervals.

Assuming detector response drift is similar for the petrochemical compounds, you need to calibrate once, immediately following instrument warm-up. Measurement of dry, pure samples at a similar concentration to the calibration concentration should then give a result accurate to within 10% for an 8 hour working period.

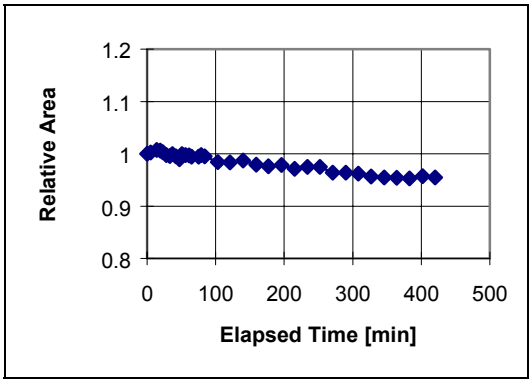


Figure 58 Peak Area Stability for Repetitive Sampling for 100 ppm Isobutylene

The numbers above are meant as a guideline. It is possible the instrument may drift more or less rapidly in practice. This will depend on your application and operating conditions. You may need to calibrate more frequently to ensure reliable results.

As a measuring instrument, Voyager has a non-linear response for many compounds. Therefore, in order to make accurate measurements at concentrations other than the calibration concentration it is necessary to correct for instrument non-linearity.

This can only be done if a multiple point calibration is performed to determine the response of the instrument throughout the concentration range of interest. If the response curve characteristics are measured in this way, then reasonably accurate measurements can be made.

Assay 7 User Notes 13

An Overview of Assay 7

Assay 7 consists of 8 compounds from the latex polymer industry. Voyager has been configured to separate and resolve as many of these target compounds as possible. However, with the standard method n-butyl acrylate and styrene co-elute on Column A. Your instrument has been set up for the Assay 7 Standard Method.

NOTE: *If necessary you can use SiteChart to customize the method for your application.*

The Assay 7 Disk

Two types of files are included on the assay disks. Application files have the extension .app. Method files are loaded through the Assay tab in SiteChart and are used to program Voyager. Assay7.app is the standard method. It provides chromatographic settings so that all compounds can be run on a single column.

Chromatograms from the photoionization detector are identified as .pid files. Assay7a.pid and Assay 7b.pid are sample chromatograms of the compounds of interest using the standard method installed on your instrument.

- Assay7.app
- Assay7A1.pid
- Assay7A2.
- Assay7B.pid

➢ Make a copy of all the files on the assay disk and use this as your working disk. Store the original disk in a safe location.

Installation

1. Copy the files onto the PC as described in *Installing your Assay Disk* on page 106.

2. Load the assay into Voyager as described in *Loading an Assay into Voyager* on page 109.

Compound Separation

Compounds of Interest

Separation of the 8 compounds is accomplished in two separate runs in which the heavy, and mid-range compounds are directed to Columns A and B, respectively, for analysis.

The heavy compounds, i-butyl acrylate, n-butyl acrylate, and styrene are analyzed on Column A, and the separation occurs on Column A, as shown in Figure 59.

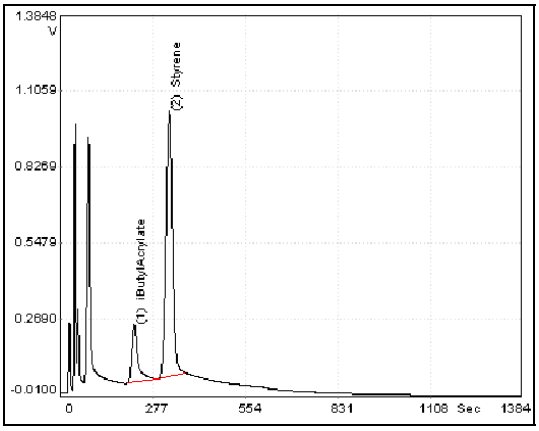


Figure 59 Run on Column A

The mid-range compounds, ethylene, vinyl acetate, methyl acrylate, ethyl acrylate, and methyl methacrylate are analyzed on Column B. Column A acts as the precolumn. The sample is injected onto Column A and the heavy and mid-range compounds are separated by adjusting the backflush time. The mid-range compounds are allowed to pass from Column A to Column B. Before the heavy compounds are able to pass into Column B, the flow is reversed, and the heavy compounds are backflushed out of Column A.

Some separation occurs on Column A, with the majority of the separation occurring on Column B, as shown in Figure 60.

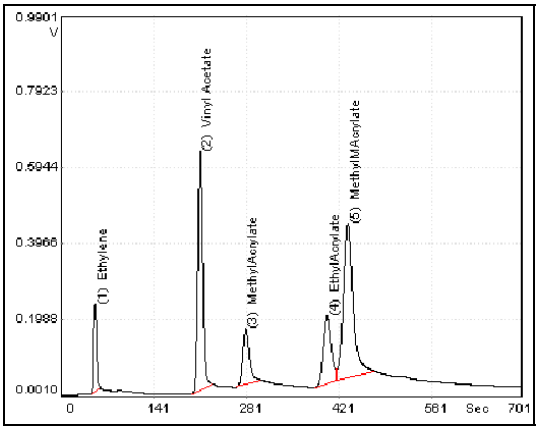


Figure 60 Run on Column B

Compound Co-elution

n-Butyl acrylate and styrene will co-elute. If only one of these compounds is present in your sample, SiteChart's Assay Wizard will allow you to select the compound of interest and advise you that the other compound may be an interference. If you require both compounds for your application, you must identify and quantify them as a co-elution.

These two compounds may be separated on Column B. Compound retention times increase significantly, but excellent separation can be obtained.

Interference Compounds

The compounds listed in the table below are possible interference compounds. These compounds are not part of Assay 7, but may be present in your application. Interference compounds are shown in Figure 61. These compounds are not listed in the library and if they are present in your analyses they will be listed as unknown.

If any of these interference compounds are present in your application, you may want to modify some chromatographic settings to ensure the best possible separation and peak identification.

n-Butanol has been run on your instrument. The analysis time in the standard method has been set to allow n-butanol to elute from Column B. If n-butanol is not present in your sample, you can modify the method to reduce the analysis time.

NOTE: *Do not alter method, if n-butanol may be present in your sample.*

Column B	R.T. (min)	R.T. (S)
Isopropyl Alcohol	1.45	86
Acrolein	2.69	161
Ethanol	4.16	249
n-Butanol	17.1	1024

NOTE: *The information above is for reference only. Actual retention times may vary significantly.*

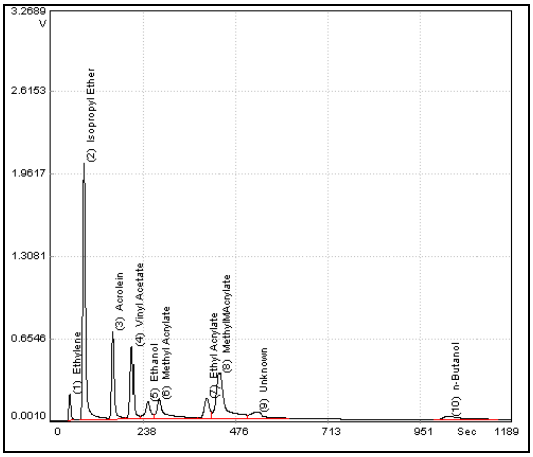


Figure 61 Column B Interference Compounds

Compound Library

Installed in Voyager, are two standard compound libraries - one for each column used in Assay 7. The libraries contain retention time and response information for each of the assay compounds. These libraries have been determined for the Assay 7 standard method. If the method is altered, these libraries are no longer valid. If the method is modified, a new library must be created, identifying the compounds with their new retention times.

For example, if the temperature of Column B is increased, the retention times in the Column B library are no longer valid, since the compounds will be eluting faster than they would in the standard method. You would have to run the compounds with the new settings and store the compound in the Library.

Compound Names

Compound names are limited to 15 characters in the Voyager library. Compound names have been shortened to fit into the Library. Names with less than 15 characters remain unchanged. The list below shows the shortened compound name.

Compound Name	Voyager Library Name
i-Butyl Acrylate	iButyl Acrylate
n-Butyl Acrylate	nButyl Acrylate
Methyl Methacrylate	MethylMAcrylate

Assay 7 Standard Method

The Assay 7 standard method, Assay7.app, has been customized for and is installed in your Voyager. The table below lists the standard method library compounds for each column, it also shows typical retention times and detectable concentration ranges for this method. These values will vary on your instrument.

Concentrations outside these specified ranges, especially at the lower end, can be obtained by adjusting the injection time, PID state and integration parameters.

NOTE: *For maximum accuracy at low concentrations, you should verify Voyager's integration, and reintegrate manually, if necessary.*

	R.T. (S)	Concentration Range (ppm)	Co-elution
Column A			
iso-Butyl Acrylate	220	1 - 100	No
neo-Butyl Acrylate	325	1 - 100	Yes
Styrene	325	1 - 60	Yes
Column B			
Ethylene	50	1 - 60	No
Vinyl Acetate	209	1 - 60	No
Methyl Acrylate	279	1 - 100	No
Ethyl Acrylate	403	0.8 - 100	No
Methyl Methacrylate	434	1 - 110	No

NOTE: *The information is for reference only. Retention times will vary significantly.*

The Assay 7 standard method also includes method parameter settings for each column. The tables below provides typical settings. The exact values will be specific to your instrument.

Method	**Column A**	**Column B**
Carrier Gas	Air	Air
Analysis Time (S)	900	1200
Oven Temperature (°C)	50	50
Pressure (psi)	12	12
PID State	High Sensitivity	High Sensitivity
Injection Method		
Inject Method	Loop Injection	Loop Injection
Inject Time (S)	1.5	1.3
Pump Time (S)	20	20
Backflush Time (S)	430	100
Integration Method		
Automatic Integration	Disabled	Disabled
Slope Up (mV/S)	0.5	0.5
Slope Down (mV/S)	1	1
Min. Height (mV)	0.0	0.0
Min. Area (mV/S)	0.0	0.0
Filter Level	3	3
Integration Delay (S)	100	40

Automatic integration should be disabled for all three compounds. Automatic integration provides maximum sensitivity for a given noise level, assuming a very flat baseline. These parameters work well for quantification of relatively large peaks but not so well for trace measurements, due to the increased effect of baseline noise.

Creating a Custom Method

You may not need to run all 8 compounds in the Assay 7 libraries. You may only be interested in a few compounds specific to your application. You can use the information provided in this document to select your compounds and then optimize the chromatography for your compounds.

There are two ways of creating a custom method. You can modify the library of an existing method. Alternatively, you optimize the chromatography of an existing method, by changing the method parameters.

General Information

Modifying the library of an existing method is a matter of adding or deleting a compound, performing a calibration and storing the compounds in a custom .app file.

Changing the method parameters allows you to create a customized method optimized for your application. You must first perform a few analyses to determine the new method's analysis and backflush times. The detailed procedures for producing custom methods are described in the *Method Development* section of this manual, a brief summary follows.

NOTE: *Do not inject heavy compounds onto Column C. They may be retained for unreasonable amounts of time, and may contaminate your column.*

1. Set the Column A backflush time to 1500 seconds and the analysis time to 3200 seconds, then analyze your target compounds on Column A.

   Column A is the precolumn for all other columns, so the retention time of the target compounds on Column A is used to determine the backflush timing the other columns

2. The backflush time for a run on Column B or C is the retention time, from Column A, of the last peak you wish to analyze plus 0 to 50 seconds.

   The backflush time for Column A is equal to the retention time of the last peak of interest plus 50 to 200 seconds, typically.

3. Column A analysis time is equal to 2.2 times the Column A backflush time.

   Since Column A is the also the precolumn, it must be backflushed for at least as long as it was foreflushed.

4. Column B and C analysis times must meet two criteria. Each must be long enough to permit the last target peak to fully elute. Again, analysis time must also be a minimum of 2.2 times the backflush time, for any given column.

   If an analysis time is too short, for either of the above reasons, peaks may elute during a later analysis.

5. Voyager's maximum analysis time is 3200 seconds, if a peak elutes after this time on any column, the method must be modified.

   Increasing the temperature or pressure will speed up slow compounds.

6. Store all target compounds in the library, and calibrate on them using the new method.

Example 1 - Compound Co-elution

n-Butyl acrylate and styrene will co-elute on Column A. If only one of these compounds is present in your sample, SiteChart's Assay Wizard will allow you to select the compound of interest and advise you that the other compound may be an interference. If you require both compounds for your application, you can identify and quantify them as a co-elution on Column A.

These two compounds can be separated on Column B. Compound retention times increase significantly, but excellent separation can be obtained. If you are also running the Column B compounds, you may find that i-butyl acrylate will co-elute with methyl methacrylate. If you must separate these compounds, you must use the standard method. To customize this method you will need to perform a run on Column A to determine the exact retention times. You will then use these times to determine the analysis and backflush times.

To simplify this example we will assume there are no known interference compounds.

1. Load assay7.app into the Assay tab of SiteChart, and save this file under a new filename.

2. Disable Column B.

3. After ensuring that Voyager is setup and ready to run an analysis, the instrument must be connected to carrier gas, and the instrument status must show Ready, perform a few runs of your sample on Column A.

   Two peaks should be identified. The first peak, i-butyl acrylate, will elute at approximately 220 seconds and the second peak, n-butyl acrylate /styrene co-elution, will elute at approximately 325 seconds.

   You will use the retention time of the latest eluting peak to set the backflush time. You cannot begin backflush until the n-butyl-acrylate/styrene peak clears Column A so allow an additional 25 seconds.

4. In the Assay tab disable Column A and enable Column B.

5. Set the Column B backflush time to 350 seconds.

6. To set Column B the analysis time multiply the retention time of the latest eluting peak by 1.1.

   Initially, you will not know the exact retention time of styrene on Column B. Set the analysis time to 3200 seconds. When styrene clears Column B (at approximately 2500 seconds) you can stop the analysis.

7. Download this method to Voyager.

8. Perform a few runs on Column B to ensure your timing is correct.

   The five Column B compounds will elute approximately as: i-Butyl acrylate will elute near or with methyl methacrylate, n-Butyl acrylate and styrene will elute approximately 2000 seconds later.

   If styrene does not clear Column B by 3200 seconds you must adjust other method parameters.

9. Perform a run and store the compounds in the Column B library.

   If possible store each compound at more than one concentration to obtain a more accurate calibration curve.

10. Save the custom method under the new name.

11. Download the final method to Voyager.

NOTE: *Analysis and backflush time are critical method parameters so the existing library information will become invalid.*

Example 2 - Reduced Analysis Time

The information in Tables 1 and 3 shows that the Column B analysis time can be reduced by 50% if n-butanol is not present in the sample matrix. To simplify this example, we will assume there are no other interference compounds.

Assuming an instrument with a standard elution, we will modify the method as follows:

1. Load assay7.app into the Assay tab of SiteChart, and save this file under a new filename.

2. Disable Column A.

3. After ensuring that Voyager is setup and ready to run an analysis, the instrument must be connected to carrier gas, and the instrument status must show Ready, perform a run of your sample.

   The standard method configures Column B for an analysis time of 1200 seconds and backflush time of 100 seconds. This provides 1100 seconds for backflushing the precolumn (Column A).

   Methyl methacrylate should elute at approximately 440 seconds.

4. Set the analysis time equal to the retention time of the latest eluting peak multiplied by 1.1.

   The analysis time for this example can be set to 600 seconds.

5. Set the backflush time.

   The backflush time must be set so that the compounds of interest clear the precolumn before backflush begins. In this case the backflush time should be set to 200 seconds. You may need to perform a run on Column A to determine when the last compound of interest clears the precolumn.

6. Perform a few runs to ensure your timing is correct and that all compounds are accurately quantified.

7. Save the custom method under the new name.

8. Download the new method to Voyager.

   Analysis time and backflush time are critical method parameters. The existing library information will become invalid. You must perform a run and store the compounds in the library. If possible store each compound at more than one concentration to obtain a more accurate calibration curve.

Column Specifications

Column A	
Length	2.5 meters (m)
Internal Diameter	0.53 millimeters (mm)
Coating Thickness	2 micrometers (um)
Coating/Packing Material	35% phenyl, 65% methyl phase capillary column (SPB-35)
Column V (TVOC)	
Length	8 m
Internal Diameter	0.25 mm
Coating Thickness	N/A
Coating/Packing Material	blank (deactivated)
Column B	
Length	20 m
Internal Diameter	0.32 mm
Coating Thickness	1.5 um
Coating/Packing Material	WAX phase capillary column (Supelcowax 10™)
Column C	
Length	4’ x 1/16”
Internal Diameter	0.040”
Coating Thickness	N/A
Coating/Packing Material	1% SP-1000 on 60/80 Carbopack® B (SPB-1)

Accurate Concentration Measurement

The following information is provided to assist you in understanding some of the analytical issues regarding the analysis of latex polymer target compounds in ambient air.

When you are detecting compound concentrations in air samples using gas chromatography, it is important to recognize that there are various potential sources of error in the measurements. These sources of error combine to give scatter in measured concentrations (measured as precision) and systematic bias to measured concentrations. You must correct for these sources of error or your results will become inaccurate.

Possible sources of error include:

- Peak integration errors.
- Sampling errors.
- Compound dependent adsorption effects.
- Detector response drift over the period of time since the last calibration.
- System accuracy.

All of these effects may contribute to inaccurate measurements in any given set of data.

Peak Integration Errors

Baseline noise, interfering peaks or excessive tailing of the target compound peak can cause problems in starting or stopping the peak integration at the optimum times. These can even cause differences in integration for consecutive runs at the same concentration. Selection of one set of integration parameters over another may result in a nonlinear area versus concentration curve.

It is impossible to completely eliminate integrator effects as a source of error over the broad range of conditions under which Voyager must operate. For this reason, it is essential that you verify the integration results by examining the chromatograms and re-integrating, if necessary. This is particularly true if the results are being used to make decisions regarding health and safety issues.

Sampling Errors

Sampling errors occur when the concentration of a compound in the gas sample presented to the analytical system is not the same as the original sample.

For example, a Tedlar® bag is filled with styrene and sampled at regular intervals. A graph of measured concentration versus time produces a curve as shown in Figure 62.

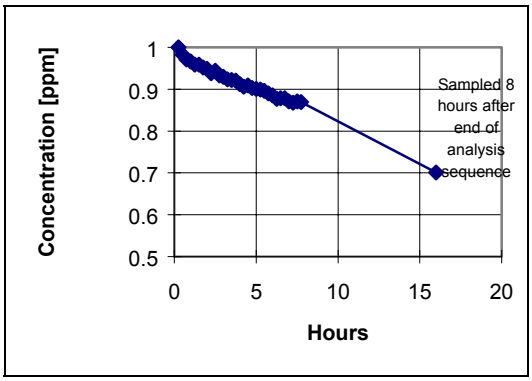


Figure 62 Gas Bag Effect as Measured on a 1 ppm Styrene Sample

The last run was performed approximately 8 hours after the initial sequence of runs. This data trend is symptomatic of adsorption of styrene by the gas bag.

If the same concentration of styrene is measured directly from a tank of compressed gas, standard drift effects over the same time period are negligible. If a Tedlar bag is used to store a styrene sample at this concentration, then the analysis results hours later will not accurately reflect the concentration at the time of sampling.

In addition to container effects, there are a variety of other issues regarding sample storage, processing and preparation which can compromise the accuracy of the concentration measurement.

Adsorption

Another potential instrument source of error is sample adsorption by Voyager's analytical system. If this occurs, it will typically be seen as an increase in peak area upon repeated sampling of the component, even after the instrument has been in operation for many hours. The effect is usually concentration dependent as higher concentrations will supply the demand of a limited number of adsorption sites without a significant percentage of sample loss.

Voyager has been designed to minimize adsorption effects by heating the analytical system. However some compounds may still be problematic at low concentrations. Each compound has been tested for adsorption effects and the results are illustrated in Figure 63 to Figure 65. These results were used to generate the precision specifications for Assay 5. The instrument being tested had not previously been exposed to the target compound. The analyses were performed with typical Assay 5 method parameters.

The adsorption test consists of repetitive sampling (10 runs) and analysis of the indicated compound concentration. The sample is typically obtained either directly from a tank or by diluting a tank standard with air to obtain the indicated concentration. The instrument was calibrated and then the 10 runs were performed. Test results are shown below for two compounds as run on one instrument, but are typical for Voyager.

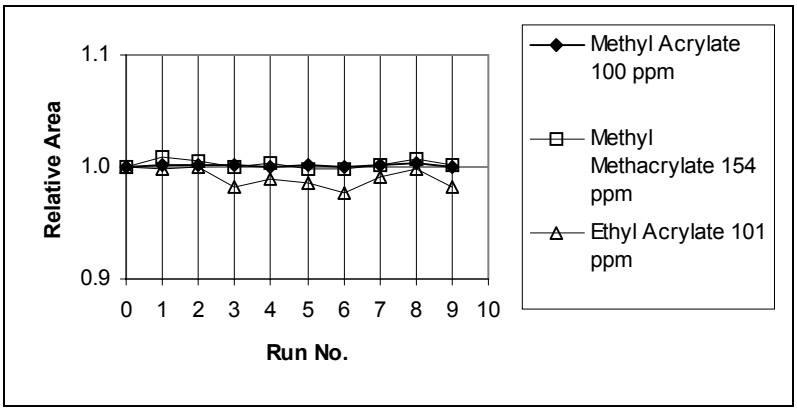


Figure 63 Peak Area Stability for Repetitive Sampling of 100 ppm Methyl Acrylate, 154 ppm Methyl Methacrylate and 101 ppm Ethyl Acrylate

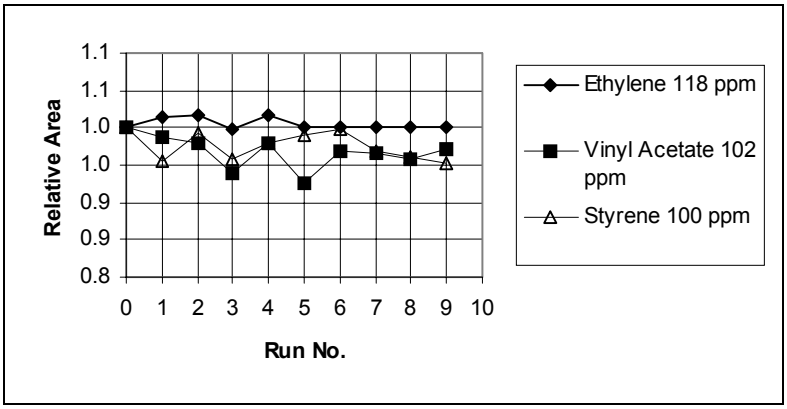


Figure 64 Peak Area Stability for Repetitive Sampling of 118 ppm Ethylene, 102 ppm Vinyl Acetate and 100 ppm Styrene

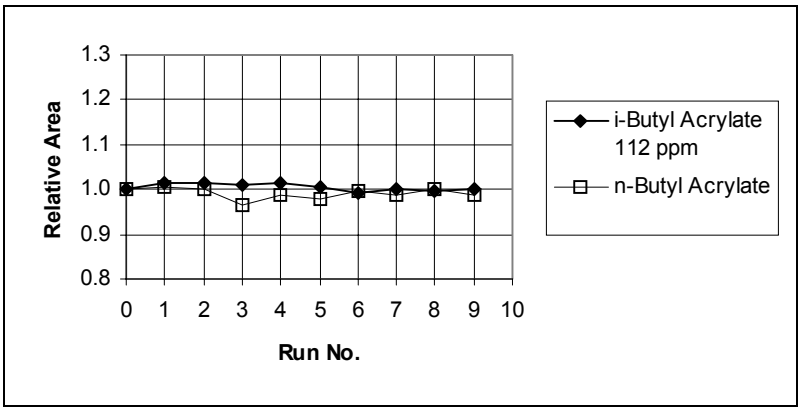


Figure 65 Peak Area Stability for Repetitive Sampling of 112 ppm i-Butyl Acrylate and 115 ppm n-Butyl Acrylate

Detector Response Drift

Detector response drift is caused by drift in the effective UV lamp intensity over time. Although Voyager automatically maintains a constant visible lamp intensity, it is possible that the ionizing spectral lines, located outside the visible range, shift in intensity over time.

Detector response drift will manifest itself as an effect that typically occurs over a longer time period than adsorption and which is not as compound specific as adsorption. Also, it is not affected by the frequency of sampling, unlike adsorption phenomena. Calibration is recommended when the detector response has changed by greater than 10%.

The table below provides a recommended maximum operating time before calibration is necessary. The instrument must be calibrated when Voyager is turned on and should be calibrated at the indicated interval thereafter. We recommend that you calibrate under similar temperature and humidity conditions as that of the sample.

Compound	TLV (ppm)	Precision % RSD* From Mean	Calibration Interval ** (Hrs)
iso-Butyl Acrylate	10	0.69@112ppm	8
neo-Butyl Acrylate	0.5	1.56@115ppm	8
Styrene	0.5	2.0@100ppm	8
Ethylene	200	0.94@118ppm	8
Vinyl Acetate	750	2.33@102ppm	8
Methyl Acrylate	200	0.09@100 ppm	8
Ethyl Acrylate		0.83@101 ppm	8
Methyl Methacrylate		0.35@154ppm	8
* Based on five consecutive samples ** Interval between calibrations for <10% change in accuracy assuming Voyager is calibrated once immediately after a 20 minute warm up period.			

The calibration information and the discussion which follows are applicable only for measurement of dry, pure, sample gases containing the target compounds at approximately calibration concentrations.

These calibration times are based on an extended measurement of peak area drift of a generic compound (isobutylene) following instrument warm-up. A Voyager which has been off for an extended period is turned on and set to auto sample and analyze isobutylene on Column B. Isobutylene is a volatile compound and so typically does not show adsorption effects. The observed peak area drift is an indication of detector drift only. The resulting area drift over a period of 400 minutes is shown in Figure 66. The change in peak area over this time period was 5%.

This drift characteristic is typical of Voyager's detector response drift, following a 20 minute warm-up period. Although this test is performed with isobutylene, the same approximate, peak area drift can be expected for any of the Assay 5 compounds. To ensure a measured concentration (at the calibration concentration) is within 10% of the actual value:

1. Calibrate once when the instrument is turned on.

   Allow 30 minutes for the instrument to stabilize before performing the calibration run(s).

2. Calibrate at 8 hour intervals.

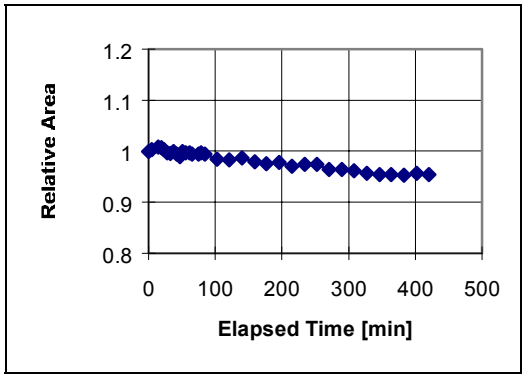


Figure 66 Peak Area Stability for Repetitive Sampling for 100 ppm Isobutylene

Assuming detector response drift is similar for the pulp and paper compounds, you need to calibrate once, immediately following instrument warm-up. Measurement of dry, pure samples at a similar concentration to the calibration concentration should then give a result accurate to within 10% for an 8 hour working period.

The numbers in the table are meant as a guideline. It is possible the instrument may drift more or less rapidly in practice. This will depend on your application and operating conditions. You may need to calibrate more frequently to ensure reliable results.

As a measuring instrument, Voyager has a non-linear response for many compounds. Therefore, in order to make accurate measurements at concentrations other than the calibration concentration it is necessary to correct for instrument non-linearity.

This can only be done if a multiple point calibration is performed to determine the response of the instrument throughout the concentration range of interest. If the response curve characteristics are measured in this way, then reasonably accurate measurements can be made.

Appendices 14

Technical Description

Voyager uses gas chromatography to separate and detect volatile organic compounds (VOCs) present in an air sample.

In a gas chromatograph (GC), the sample is carried from the point of introduction, through a separating column, and then out through a detector, by a continuous stream of relatively inert gas called carrier gas. The column in a GC is a long tube with sticky or sorptive material coating the inside walls or packed into the tube. The sample components become separated from one another as they are carried through the column because of differences in their rates of interaction with the sorptive material. Each different sample component is therefore retained for a different length of time within the column, and elutes from the column into the detector at a characteristic retention time.

The detector responds as each component flows through the detector cell. If the detector response is displayed against the elapsed time, then a series of peaks separated in time is seen, one peak for each sample component. The retention time of the tip of each peak indicates what the sample component is, and the area of the peak indicates how much is present.

Chromatography is a comparative technique of analysis. The identities and concentrations reported by Voyager after a sample is analyzed are based on the retention times and peak sizes of previously analyzed standards. When an assay is set up in Voyager, a standard of each compound of interest is stored in Voyager’s memory by retention time, peak area, and concentration. The ratio of peak area to concentration is the sensitivity (the response to concentration ratio, measured in mVS/ppm) for the compound. This information is saved in a part of Voyager's memory called the library, and is automatically updated during a calibration.

In each sample analysis, peak retention times are compared to retention times of library compounds. If they match (within the limits of the peak recognition window), then the peak is identified as the corresponding library compound. To calculate the concentration of the identified peak, its area is divided by the library sensitivity for the compound.

Library retention times and sensitivities are updated whenever Voyager is calibrated. Voyager also calculates the new retention time to old retention time ratio for each library compound in the calibration gas. If a library compound is not present in the calibration gas, Voyager updates its retention time by multiplying it by an average calculated from compounds in the calibration gas.

Sample Introduction

Samples can be introduced into a GC either automatically or manually. Voyager accepts air and gas samples both ways.

If you have a large volume of sample available, as is usually the case in ambient air sampling, then automatic sample injection is the easiest means of introduction. This is done using Voyager's internal sampling pump and sample loop. When the sample pump is on, the sample is drawn in through Voyager's sample in port, then through a fixed volume called a sample loop, then through the pump to be vented through the pump out port. The sample loop has gas switching valves at either end of it. Once the sample loop is full of sample gas, the pump stops and these valves switch to connect one end of the loop to the carrier gas supply and the other end of the loop to the beginning or head of the GC column. Carrier gas then sweeps the sample from the loop onto the column for analysis. Once the sample has been injected, the carrier gas flow is again switched, this time to bypass the loop and continue to feed the column.

Although the sample loop volume is fixed in Voyager, it is possible to inject only a part of the loop volume. This is done by switching the carrier gas to bypass the loop before the entire loop volume has been swept onto the column.

To use automatic sample loop injection, you must have sufficient sample at atmospheric pressure available for the sample pump to draw through the sample loop and connecting tubing. If you have a only a limited amount of sample available, such as headspace in a vial above a soil or water sample, then manual sample injection is required. This is done using a gas tight syringe and Voyager's injection port.

The injection port is located in the carrier gas stream just before the head of the column, and contains a septum, which is a silicone disc coated with Teflon. The sample is collected in the gas tight syringe, then the syringe needle is pushed through the septum. The syringe plunger is depressed to inject the gas sample into the carrier gas stream and onto the head of the column for analysis, and finally the needle is withdrawn.

Precolumn Backflushing

The analysis in a GC is complete once all the sample components have been carried the length of the column and have flowed through the detector. The analysis time is therefore determined by the retention time of the most-retained sample component. If a second sample is introduced onto the GC column before the first analysis is completed, it is possible for little-retained components in the second sample to flow through the detector at the same time as more-retained components in the first sample. This leads to difficulty in interpreting the detector output signal.

To avoid this, a technique known as precolumn backflushing is used in Voyager. Here, two GC columns, a shorter precolumn and a longer analytical column, are joined in series with a tee between them. Initially the branch of the tee is closed to flow and carrier gas is directed along the precolumn, through the run of the tee, and then through the analytical column to the detector. The sample is introduced onto the head of the precolumn and carried along the precolumn towards the analytical column. After an interval of time the carrier gas is switched and introduced at the branch of the tee between the two columns. Those sample components which have already passed the tee continue to be carried towards the detector along the analytical column. Those which are still in the precolumn are flushed backwards along the precolumn and vented from the head of the precolumn.

Backflushing of the precolumn to clean it for the next sample occurs while the analysis continues on the analytical column. Once all components have eluted from both columns, the carrier gas can be switched back to flow through both columns in series in preparation for the next sample.

Precolumn backflushing reduces total analysis time in Voyager. It is not necessary to wait for the longer retained components that are not required, to pass through the analytical column. Precolumn backflushing also increases analytical confidence by reducing the possibility of peaks from an earlier analysis eluting during a later analysis.

Column Selection

In a GC, the types of sample components which can be separated from one another are dictated by the type of GC column used. Some column types are suited to light gases, others to heavier vapors, and yet others to polar vapors. For flexibility in the types of compounds which can be analyzed in a GC, it is necessary to have several different types of columns installed so that the optimum column can be selected for the particular analysis. This is typically done by having you, the GC user, remove and replace columns within the GC instrument.

In Voyager, four columns are installed and kept ready for use. Refer to the user notes supplied with your assay for detailed specifications of the columns installed in your instrument and how to use the columns for your application.

In TVOC mode, no gas chromatography is performed on the sample. Instead, the sample is introduced into a stream of carrier gas and carried directly to the detector. All separating columns are bypassed. The detector response is a single peak which represents the composite of all detectable compounds in the sample.

Photoionization Detector

The photoionization detector (PID) consists of a detector cell through which the column effluent flows, and a lamp that directs ultraviolet (UV) light into the cell. In Voyager, the lamp is an electrodeless discharge tube, and is made to light using a high-frequency (HF) driver circuit.

The lamp contains low pressure gas into which the high frequency energy is coupled through an antenna wrapped around the lampholder. The HF driver circuit is controlled by Voyager's microprocessor based on a feedback signal from a light sensor on the HF driver circuit board.

Dissipation of the HF energy in the gas inside the lamp causes the gas to glow with a bright blue-violet light. UV light with a wavelength of 120 nanometers (nm) is also produced. UV light of this wavelength carries 10.6 electron volts (eV) of energy. The UV light is emitted from the lamp and is directed at the stream of carrier gas eluting from the column. When light of this energy hits the eluting molecules, they may become ionized; that is, electrons may be knocked off the molecules.

Many of the chemicals considered pollutants, including most hydrocarbons, are ionized. The permanent air gases (argon, carbon dioxide, nitrogen, oxygen, water vapor etc.) require a relatively high energy for ionization, and are not ionized by the 10.6 eV UV lamp.

Whether or not a certain molecule is ionized depends upon its Ionization Potential (IP). If the IP of a molecule is less than the energy of the light, 10.6 eV, it will most likely be ionized. If the IP is greater than 10.6 eV, it is not readily ionized. Most of the permanent air gases including nitrogen and water vapor have IPs over 12 eV. This means that the carrier gas and the sample matrix are not ionized.

A continuous electric field is maintained between a repeller electrode and a collector electrode in the PID cell. Once they have been ionized by the lamp, the ionized molecules in the PID cell move in the electric field, generating a current which is proportional to the concentration of the ionized molecules in the detector cell. An electrometer circuit converts the current to a voltage, which is then further converted to a digital signal and fed to Voyager's microprocessor.

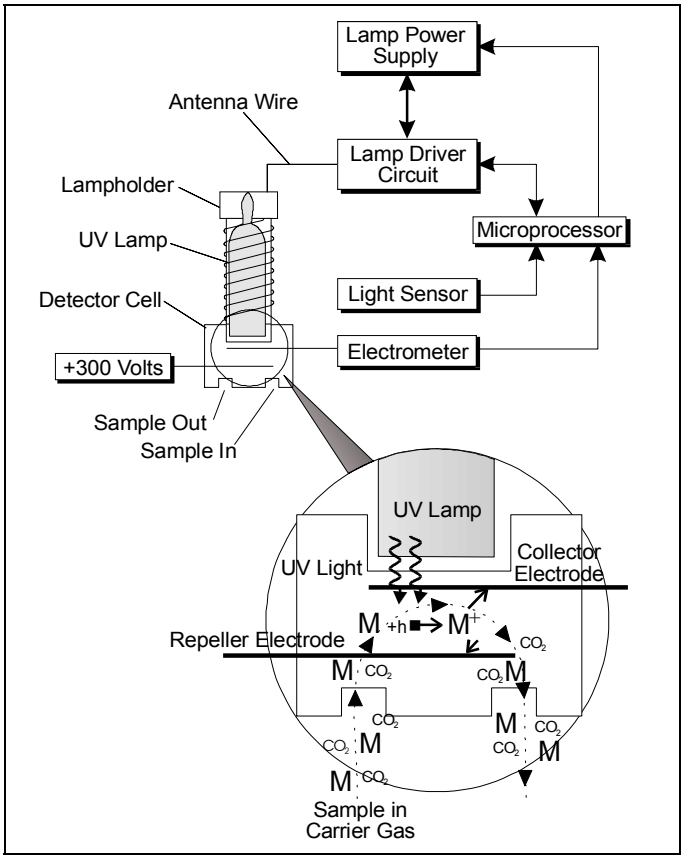


Figure 67 Photoionization Detector

Analytical Engine

The GC functions, sample loop injection, syringe injection, precolumn backflushing, column selection, TVOC operation, and detection require a sophisticated circuit of gas flow switching valves. All the parts of this circuit of valves and interconnections that contact the sample should be chemically inert to preserve the quality of the analysis and to reduce sample degradation. They should all be maintained at elevated temperature to avoid any condensation of sample components. Interconnecting volumes should be kept small to minimize any peak broadening.

In Voyager, these GC design requirements have been met by fabricating an array of 21 inert, low-volume gas switching valves, with interconnections, in an internally-heated monolithic assembly. The other GC components (injection port, precolumn, analytical columns, and detector) are mounted and thermally linked to this valve array, to create a compact analytical engine.

Electron Capture Detector

The electron capture detector (ECD) is sensitive to chemical compounds called electrophilic compounds, which attract free electrons. The ECD is especially sensitive to hydrocarbons which contain atoms of chlorine or bromine.

In the ECD cell there is an electron source which generates electrons at a constant rate, and a collector electrode for collecting electrons. When an electrophilic compound passes through the ECD, it captures some of the generated electrons, and causes the rate of collection at the collector electrode to fall. This decrease in electron current is the detector response.

The ECD cell contains a cylinder of nickel foil through which the carrier gas flows. Coated on the foil's inner surface is a quantity of the radioactive isotope nickel-63 which emits electrons at the rate of about 500 million per second.

Electrons emitted from the nickel-63 collide with and ionize the carrier gas, creating more electrons. The resultant ions and electrons travel to the collector electrode under the influence of a pulsed voltage applied between the nickel-63 electron source and the collector electrode. This flow of ions and electrons is the cell background current. The pulse frequency is varied to maintain a constant average background current. An electrophilic compound in the detector decreases the cell current as the compound captures electrons and forms ions, which travel more slowly than electrons. The pulse frequency of the polarizing supply is automatically raised to maintain a constant current in the cell. This frequency is the detector output signal and is fed to Voyager's microprocessor.

You must use nitrogen carrier gas as the oxygen in air will absorb electrons and reduce the sensitivity of the ECD.

In Voyager the column effluent is split between the PID and the ECD. Make-up gas is supplied to the ECD in order to maintain a constant flow rate over the detector and to ensure stability. The low flows normally put though a capillary column may reduce the baseline. The makeup gas is added to the column effluent before it enters the detector to maintain the flow through the ECD at a level that will ensure a stable signal level.

The AC Adapter Line Cord

In most cases Voyager will be shipped with an AC line cord that will fit the AC wall outlet in your area. If this cannot be done, you may need to obtain an AC line cord suitable for the AC receptacle in your area.

The AC line cord, attached plug and receptacle must be marked with your country's certification mark and the cord must have a Harmonization (HAR) Mark.

The line cord must be rated for either 100 to 120 VAC at 60 Hz or 220 to 240 VAC at 50 Hz. The voltage rating will depend on the voltage in your area.

Contact your local PerkinElmer Photovac representative to obtain more information.

Calibration Gas

It is recommended that commercially analyzed calibration gas and associated regulators be used with Voyager.

The compounds and the concentration of the calibration gas will depend on your application. When ordering calibration gas, specify each compound and concentration. Specify 5% blend tolerance, and 2% analytical tolerance.

Standards must be made up in hydrocarbon free air. Balance air should not have more than 0.1 ppm total hydrocarbons (THC). If your standards are unstable in air or if you are using nitrogen as carrier gas you may obtain your calibration standards made up in nitrogen. Balance nitrogen should not have more than 0.1 ppm total hydrocarbons (THC).

When selecting calibration gas, keep in mind the upper and lower limits of the assay. Try to obtain each compound at a concentration that is close to the your value of interest.

Obtain a calibration gas regulator, with 1/4" compression fitting outlet. Use only the specified regulator for your calibration gas. Confirm regulator type and material with your specialty gas supplier.

Warranty and Service Information

Voyager is warranted for one year against defects in materials and workmanship.

PerkinElmer Photovac warrants that its manufactured product will be free from defects in materials and workmanship for a period of one (1) year from the date of receipt by the Customer. This may be voided if, in the opinion of PerkinElmer Photovac, the product has been abused or treated in a negligent manner so as to cause damage or failure. Negligent use includes, but is not limited to, exposure of the internal parts of the equipment to water. Damage caused thereby is expressly excluded from this Warranty.

Consumable supplies and parts routinely replaced are not warranted.

PerkinElmer Photovac and its vendors disclaim any implied warranty of merchantability or fitness for a particular purpose. PerkinElmer Photovac and its vendors will not be liable for any indirect, special, incidental, or consequential damages, irrespective of whether PerkinElmer Photovac or the vendor has advance notice of the possibility of such damages.

PerkinElmer Photovac's sole liability under this warranty is limited to the repair or replacement of the product at its Service/Repair facility and return to the Customer.

When PerkinElmer Photovac is made aware of a problem that would be eligible for remedy under Warranty, it will issue a Return Authorization Number to the Customer. No return will be accepted unless such authorization has been obtained. The customer is responsible for insurance and shipping to the designated PerkinElmer Photovac Service/Repair facility.

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9.3 Waiver—The failure of any party to enforce any term or condition of this license shall not constitute a waiver of that party's right to enforce any term or condition of this License unless waived in writing.

9.4 Governing Law—This license shall be interpreted and governed by the law of the State of Connecticut.

9.5 Notices—All notices shall be in writing and sent by registered or certified mail, return receipt requested. The date notice is received shall be the effective date.

Contacting PerkinElmer Photovac

To place an order, check the status of an order, obtain current pricing and availability	(800) 762-4000
Service and repair of your instrument	(800) 762-4000 x5050
Applications Department	(800) 762-4000 x5040
In Europe	PerkinElmer Photovac Europa Sjælsø Allé 7 A P.O. Box 79 DK-3450 Allerød, Denmark Tel: +45-48-100-400 Fax: +45-48-100-401
In all other areas contact your PerkinElmer Photovac representative.	

Instrument Specifications

Dimensions:	15.4” (39 cm) long, 10.6” (27 cm) wide, 5.9” (15 cm) high
Weight:	15 lbs (6.8 kg)
Detectors:	Photoionization, with standard 10.6 eV HF-excited electrodeless discharge tube.
Keyboard:	8 push buttons. 4 fixed function and 4 soft keys
Display	Backlit, liquid crystal, 128 x 64 graphic array
Battery Pack Type:	Nickel-cadmium sealed cell
Battery Heavy Metal Content:	20% Cadmium by weight
Charge/Discharge Time:	6 hr/5 hr
Power Requirements:	Single 10 V to 18 V DC source, 3 A maximum. AC adapter supplied
System Memory:	256k internal RAM, 175k for datalogging
Serial Output:	RS-232, 9600 baud
Alarm Output:	Internal audio, 85 dB, Alarm LED
Inlet Connection:	1/4” stainless steel compression fitting
Inlet Filter:	Replaceable Teflon/Polypropylene, 1 um
Materials in Sample Stream:	Stainless steel, Teflon backed septum for syringe injection
Chromatography:	Auto-inject precolumn backflush, with miniature, inert, switching valves and isothermal widebore capillary columns. Packed 1/16” columns are used for some applications.
Operating Temperature Range:	5 °C to 40 °C (41 °F to 105 °F)
Operating Humidity Range:	0 to 95% (non-condensing)

Title 10, Chapter 1 CFR - Energy

NOTE: *Users of the information in this section are advised that it is provided for the convenience of reference only and as such has no official sanction. The original regulations and amendments thereto should be consulted for all purposes of interpreting and applying the law.*

Sections 20.2201 and 20.2202

§20.2201 Reports of Theft or Loss of Licensed Material

(a) Telephone Reports

(1) Each licensee shall report by telephone as follows:

(i) Immediately after its occurrence becomes known to the licensee, any lost, stolen, or missing licensed material in an aggregate quantity equal to or greater than 1000 the quantity specified in appendix C to part 20 under such circumstances that it appears to the licensee that an exposure could result in unrestricted areas; or

(ii) Within 30 days after the occurrence of any lost, stolen, or missing licensed material becomes known to the licensee, all licensed material in a quantity greater than 1000 the quantity specified in appendix C to part 20 that is still missing at this time.

(2) Reports must be made as follows:

(i) Licensees having an installed Emergency Notification System shall make the reports to the NRC Operations Center in accordance with §60.72 of this chapter, and

(ii) All other licensees shall make reports by telephone to the NRC Operations Center (301-961-0550).

(b) Written Reports

(1) Each licensee required to make a report under paragraph (a) of this section shall, within 30 days after making the telephone report, make a written report setting forth the following information:

(i) A description of the licensed material involved, including kind, quantity and chemical and physical form; and

(ii) A description of the circumstances under which the loss or theft occurred; and

(iii) A statement of disposition or probable disposition of the licensed material involved; and

(iv) Exposures of individuals to radiation, circumstances under which the exposure occurred, and the possible total effective dose equivalent to persons in unrestricted areas; and

(v) Actions that have been taken, or will be taken, to recover the material; and

(vi) Procedures or measures that have been or will be adopted to ensure against a recurrence of the loss or theft of licensed material.

(2) Reports must be made as follows:

(i) For holders of an operating license for a nuclear power plant, the events included in paragraph (b) of this section must be reported in accordance with the procedures described in §50.73 (b), (c), (d), (e) and (g) of this chapter and must include the information required in paragraph (b)(1) of this section, and

(ii) All other licensees shall make reports to the Administrator of the appropriate NRC Regional Office listed in appendix D to part 20.

(c) A duplicate report is not required under paragraph (b) of this section if the licensee is also required to submit a report pursuant to §§30.55(c), 40.64(o), 50.72, 50.73, 70.52, 73.27(b), 73.67(e)(3)(vi), 73.67(g)(3)(iii), 79.71, or §150.19(c) of this chapter.

(d) Subsequent to filing the written report the licensee shall also report any additional substantive information on the loss or theft within 30 days after the licensee learns of such information.

(e) The licensee shall prepare any report filed with the Commission pursuant to this section so that names of individuals who have received exposure to radiation are stated in a separate and detachable part of the report.

[66 FR 23406, May 31, 1991, as amended at 58 FR 69220, Dec. 30, 1993; 60 FR 20186, Apr. 25, 1996]

§20.2202 Notification of Incidents

(a) Immediate Notification. Notwithstanding any other requirements for notification, each licensee shall immediately report any event involving byproduct, source or special nuclear material possessed by the licensee that may have caused or threatens to cause any of the following conditions—

(1) An individual to receive—

(i) A total effective dose equivalent of 25 rems (0.25 Sv) or more; or

(ii) An eye dose equivalent of 75 rems (0.75 Sv) or more; or

(iii) A shallow dose equivalent to the skin or extremities of 250 rads (2.5 Gy) or more; or

(2) The release of radioactive material. Inside or outside of a restricted area, so that had an individual been present for 24 hours, the individual could have received an intake five times the annual limit on intake (the provisions of this paragraph do not apply to locations

where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures.).

(b) Twenty-four hour notification. Each licensee shall, within 24 hours of the discovery of the event, report any event involving loss of control of licensed material possessed by the licensee that may have caused or threatens to cause any of the following conditions:

(1) An individual to receive, in a period of 24 hours—

(i) A total effective dose equivalent of 6 rems (0.05 Sv) or more; or

(ii) An eye dose equivalent exceeding 15 rems (0.15 Sv) or more; or

(iii) A shallow dose equivalent to the skin or extremities exceeding 50 rems (0.5 Sv); or

(2) The release of radioactive material. Inside or outside of a restricted area, so that had an individual been present for 24 hours, the individual could have received an intake in excess of one occupational annual limit on intake (the provisions of this paragraph do not apply to locations where personnel are not normally stationed during routine operations, such as hot-cells or process enclosures).

(c) The licensee shall prepare any report filed with the Commission pursuant to this section shall be prepared so that names of individuals who have received exposure to radiation or radioactive material are stated in a separate and detachable part of the report.

(d) Reports made by licensees in response to the requirements of this section must be made as follows:

(1) Licensees that have an installed Emergency Notification System shall make the reports required by paragraphs (a) and (b) of this section to the NRC Operations Center in accordance with 10 CFR 60.72; and

(2) All other licensees shall make the reports required by paragraphs (a) and (b) of this section by telephone to the NRC Operations Center (301) 816-5100 and by telegram, mailgram or facsimile to the Administrator of the appropriate NRC Regional Office listed in Appendix D to 10 CFR part 20.

(e) The provisions of this section do not include doses that result from planned special exposures, that are within the limits for planned special exposures, and that are reported under §20.2204.

[66 FR 23406, May 21, 1991, as amended at 66 FR 40766, August 16, 1991; 67 FR 67879, Dec. 8, 1992; 69 FR 14086, Mar 26, 1994]

Section 30.34

§30.34 Terms and Conditions of License

(a) Each license issued pursuant to the regulations in this part and the regulations in parts 31 through 35 and 39 of this chapter shall be subject to all the provisions, of the Act, now or hereafter in effect, and to all valid rules, regulations, and orders of the Commission.

(b) No license issued or granted pursuant to the regulations in this part and the regulations in Parts 31 through 35 and 39 nor any right under a license shall be transferred, assigned or in any manner disposed of, either voluntarily or involuntarily, directly or indirectly, through transfer of control of any license to any person, unless the Commission shall, after securing full information, find that the transfer is in accordance with the provisions of the Act, and shall give its consent in writing.

(c) Each person licensed by the Commission pursuant to the regulations in this part and the regulations in parts 31 through 35 and 39 shall confine his possession and use of the byproduct material to the locations and purposes authorized in the license. Except as otherwise provided in the license, a license issued pursuant to the regulations in this part and parts 31 through 35 and 39 of this chapter shall carry with it the right to receive, acquire, own, and possess byproduct material. Preparation for shipment and transport of byproduct material shall be in accordance with the provisions of part 71 of this chapter.

(d) Each license issued pursuant to the regulations in this part and parts 31 through 35 and 39 shall be deemed to contain the provisions set forth in section 183b.-d., inclusive, of the Act, whether or not these provisions are expressly set forth in the license.

(e) The Commission may incorporate, in any license issued pursuant to the regulations in this part and parts 31 through 35 and 39, at the time of issuance or thereafter by appropriate rule, regulation or order, such additional requirements and conditions with respect to the licensee's receipt, possession, use and transfer of byproduct material as it deems appropriate or necessary in order to:

(1) Promote the common defense and security;

(2) Protect health or to minimize danger to life or property;

(3) Protect restricted data;

(4) Require such reports and the keeping of such records, and to provide for such inspections of activities under the license as may be necessary or appropriate to effectuate the purposes of the Act and regulations thereunder.

(f) Licensees required to submit emergency plans by §30.32(1) shall follow the emergency plan approved by the Commission. The licenses may change the approved plan without Commission approval only if the changes do not decrease the effectiveness of the plan. The licensee shall furnish the change to the appropriate NRC Regional Office specified in §30.6 and to affected offsite response organizations within six months after the change is made. Proposed changes that decrease, or potentially decrease, the effectiveness of the approved emergency plan may not be implemented without prior application to and prior approval by the Commission.

(g) Each licensee preparing technetium-99m radiopharmaceuticals from molybdenum-99/technetium-99m generators shall test the generator eluates for molybdenum-99 breakthrough in accordance with 35.204 of this chapter. The licensee shall record the results of each test and retain each record or three years after the record is made.

(h) (1) Each licensee shall notify the appropriate NRC Regional Administrator, in writing, immediately following the filing of a voluntary or involuntary petition for bankruptcy under any chapter of title 11 (Bankruptcy) of the United States Code by or against;

(i) The licensee;

(ii) An entity (as that term is defined in 11 U.S.C. 101(14)) controlling the licensee or listing the license or licensee as property of the estate; or

(iii) An affiliate (as that term is defined in 11 U.S.C. 101(2)) of the licensee.

(2) This notification must indicate:

(i) The bankruptcy court in which the petition for bankruptcy was filed; and

(ii) The date of the filing of the petition.

[30 FR 8185, June 26, 1965, as amended at 38 FR 33969, Dec. 10, 1973; 43 FR 6922, Feb. 17, 1978: 48 FR 32328. July 15, 1983;52 FR 1295, Jan. 12, 1987; 52 FR 8241, Mar. 17, 1987; 53 FR 19245, May 27, 1988; 53 FR 23383, June 22, 1988; 54 FR 14061, Apr. 7, 1989; 68 FR 7736, Feb. 9, 1993;59 FR 61780, Dec. 2, 1994]

Sections 30.51, 30.52 and 30.53

Records, Inspections, Tests and Reports

§30.51 Records

(a) Each person who receives by product material pursuant to a license issued pursuant to the regulations in this part and parts 31 through 35 of this chapter shall keep records showing the receipt, transfer, and disposal of the byproduct material as follows:

(1) The license shall retain each record of receipt of byproduct material as long as the material is possessed and for three years following transfer or disposal of the material.

(2) The licensee who transferred the material shall retain each record of transfer for three years after each transfer unless a specific

requirement in another part of the regulations in this chapter dictates otherwise.

(3) The licensee who disposed of the material shall retain each record of disposal of byproduct material until the Commission terminates each license that authorizes disposal of the material.

(b) The licensee shall retain each record that is required by the regulations in this part and parts 31 through 35 of this chapter or by license condition for the period specified by the appropriate regulation or license condition. If a retention period is not otherwise specified by regulation or license condition, the record must be retained until the Commission terminates each license that authorizes the activity that is subject to the record keeping requirement.

(c) (1) Records which must be maintained pursuant to this part and parts 31 through 35 of this chapter may be the original or a reproduced copy or microform if such reproduced copy or microform is duly authenticated by authorized personnel and the microform is capable of producing a clear and legible copy after storage for the period specified by the Commission regulations. The record may also be stored in electronic media with the capability for producing legible, accurate, and complete records during the required retention period. Records such as letters, drawings, specifications, must include all pertinent information such as stamps, initials, and signatures. The licensee shall maintain adequate safeguards against tampering with and loss of records.

(2) If there is a conflict between the Commission's regulations in this part and parts 31 through 35 and 39 of this chapter, license condition, or other written Commission approval or authorization pertaining to the retention period for the same type of record, the retention period specified in the regulations in this part and parts 31 through 35 and 39 of this chapter for such records shall apply unless the Commission, pursuant to §30.11, has granted a specific exemption from the record retention requirements specified in this part or parts 31 through 35 and 39 of this chapter.

[41 FR 18301, May 5, 1976, as amended at 43 FR 6922, Feb. 17, 1978; 52 FR 8241, Mar. 17, 1987; 53 FR 19245, May 27, 1988; 58 FR 7736, Feb. 8, 1993]

§30.52 Inspections

(a) Each licensee shall afford to the commission at all reasonable times opportunity to inspect byproduct material and the premises and facilities wherein byproduct material is used or stored.

(b) Each licensee shall make available to the Commission for inspection upon reasonable notice, records kept by him pursuant to the regulations in this chapter.

[30 FR 8185, June 26, 1965]

§30.53 Tests

Each licensee shall perform or permit the Commission to perform such test as the Commission deems appropriate or necessary for the administration of the regulations in this part and parts 31 through 35 and 39 of this chapter, including tests of :

(a) Byproduct material;

(b) Facilities wherein byproduct material is utilized or stored;

(c) Radiation detection and monitoring instruments ; and

(d) Other equipment and devices used in connection with the utilization or storage of byproduct material.

[30 FR 8185, June 26, 1965, as amended by 43 FR 6922, Feb. 17. 1978; 52 FR 8241, Mar. 17, 1987, 58 FR 7736, Feb. 8, 1993]

Section 31.5

§31.5 Certain Measuring, Gauging or Controlling Devices[1].

(a) A general license is hereby issued to commercial and industrial firms and research, educational, and medical institutions, individuals in the conduct of their business and Federal, State or local government agencies to acquire, receive, possess, use, or transfer in accordance with the provisions of paragraphs (b), (c) and (d) of this section, byproduct

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[1] Persons possessing byproduct material in devices under the general license in §31.5 before Jan. 15, 1975, may continue to possess, use or transfer that material in accordance with the requirements of §31.5 in effect on Jan. 14, 1975.

material, contained in devices designed and manufactured for the purpose of detecting, measuring, gauging, or controlling thickness, density, level, interface location, radiation, leakage, or qualitative or quantitative chemical composition, or for producing light or an ionized atmosphere.

(b) The general license in paragraph (a) of this section applies only to byproduct material contained in devices which have been manufactured or initially transferred and labeled in accordance with the specifications contained in a specific license issued pursuant to §32.61 of this chapter or in accordance with the specifications contained in a specific license issued by an Agreement State, which authorizes distribution of devices to persons generally licensed by the Agreement State.

(c) Any person who acquires, receives, possesses, uses, or transfers byproduct material in a device pursuant to the general license in paragraph (a) of this section:

(1) Shall assure that all labels affixed to the device at the time of receipt, and bearing a statement that removal of the label is prohibited, are maintained thereon and shall comply with all instructions and precautions provided by such labels;

(2) Shall assure that the device is tested for leakage of radioactive material and proper operation of the on-off mechanism and indicator, if any, at no longer than six-month intervals or at such other intervals as are specified in the label; however,

i) Devices containing only krypton need not be tested for leakage of radioactive material, and

ii) Devices containing only tritium or not more than 100 microcuries (3.7 MBq) of other beta and/or gamma emitting material or 10 microcuries (0.37 MBq) of alpha emitting material and devices held in storage in the original shipping container prior to initial installation need not be tested for any purpose;

(3) Shall assure that the tests required by paragraph (c)(2) of this section and other testing, installation, servicing and removal from installation involving the radioactive materials, its shielding or containment, are performed:

i) In accordance with the instructions provided by the labels, or

ii) By a person holding a specific license pursuant to parts 30 and 32 of this chapter or from an Agreement State to perform such activities;

(4) Shall maintain records showing compliance with the requirements of paragraphs (c)(2) and (c)(3) of this section. The records must show the results of tests. The records must also show the dates of performance of, and the names of persons performing, testing, installing, servicing and removing from the installation radioactive material and its shielding or containment. The records also must show the dates of performance of, and the names of persons performing testing, installing, servicing and removal from the installation of radioactive material, its shielding or containment. The licensee shall retain these records as follows:

(i) Each record of a test for leakage of radioactive material required by paragraph (c)(2) of this section must be retained for three years after the next required leak test is performed or until the sealed source is transferred or disposed of.

(ii) Each record of a test of the on-off mechanism and indicator required by paragraph (c)(2) of this section must be retained for three years after the next required test of the on-off mechanism and indicator is performed or until the sealed source is transferred or disposed of.

(iii) Each record that is required by paragraph (c)(3) of this section must be retained for three years from the date of the recorded event or until the device is transferred or disposed of.

(5) Upon the occurrence of a failure of or damage to, or any indication of a possible failure of or damage to, the shielding of the radioactive

material or the on-off mechanism or indicator, or upon the detection of 0.005 microcurie or more of removable radioactive material, shall immediately suspend operation of the device until it has been repaired by the manufacturer or other person holding a specific license pursuant to parts 30 and 32 of this chapter or from an Agreement State to repair such devices, or disposed of by transfer to a person authorized by a specific license to receive the byproduct material contained in the device and, within 30 days, furnish to the Administrator of the appropriate Nuclear Regulatory Commission, Regional Office listed in Appendix D of part 20 of this chapter, a report containing a brief description of the event and the remedial action taken;

(6) Shall not abandon the device containing byproduct material;

(7) Shall not export the device containing byproduct material except in accordance with part 110 of this chapter;

(8) Except as provided in paragraph (c)(9) of this section shall transfer or dispose of the device containing byproduct material only by transfer to a person holding a specific license pursuant to parts 30 and 32 of this chapter or from an Agreement State, to receive the device and within 30 days after transfer of a device to a specific licensee shall furnish to the Director of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington D.C. 20555, a report containing identification of the device by manufacturer's name and model number and the name and address of the person receiving the device. No report is required if the device is transferred to the specific licensee in order to obtain a replacement device;

(9) Shall transfer the device to another general licensee only:

(i) Where the device remains in use at a particular location. In such case the transferor shall give the transferee a copy of this section and any safety documents identified in the label on the device and within 30 days of the transfer, report to the Director of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D. C. 20555, the

manufacturer's name and model number of device transferred, the name and address of the transferee and the name and/or position of an individual who may constitute a point of contact between the Commission and the transferee; or

(ii) Where the device is held in storage in the original shipping container at its intended location of use prior to initial use by a general licensee;

(10) Shall comply with the provisions of §§20.2201 and 20.2202 of this chapter for reporting radiation incidents, theft, or loss of licensed material, but shall be exempt from the other requirements of Parts 19, 20 and 21 of this chapter.

(d) The general license in paragraph (a) of this section does not authorize the manufacture or import of devices containing byproduct material.

[39 FR 43532, Dec. 16, 1974, as amended at 40 FR 8785, Mar. 3, 1975; 40 FR 14085, Mar. 28, 1975; 42 FR 25721, May 19, 1977; 42 FR 28896, June 6, 1977; 43 FR 6922, Feb. 17, 1978; 53 FR 19246, May 27, 1988; 56 FR 23471, May 21, 1991; 56 FR 61352, Dec. 3, 1991; 58 FR 67659, Dec. 22, 1993]

Canadian Atomic Energy Control Regulations

NOTE: *Users of the information in this section are advised that it is provided for the convenience of reference only and as such has no official sanction. The original Regulations and amendments thereto should be consulted for all purposes of interpreting and applying the law.*

Part II, Sections 3 to 7

Part II Prescribed Substances and Items

3. Subject to section 6, no person shall, unless exempted in writing by the Board, produce, mine, prospect for, refine, use, sell or possess for any purpose any prescribed substance except in accordance with a license issued pursuant to section 7.

4. Subject to section 6 [and subsection 18.1(5)], no person shall, unless exempted in writing by the Board, use, sell, or possess any device or equipment containing radioactive prescribed substances except in accordance with a license issued pursuant to section 7.

[5. (1) No person shall

(a) import any prescribed substance,

(b) export any prescribed substance, or

(c) export any prescribed item.]

except in accordance with a license issued pursuant to section 7.

(2) A license referred to in section (1) shall be produced by or on behalf of the licensee to a collector of customs at the port of entry into or exit from Canada of the prescribed substance or prescribed item, as the case may be, or at such other place as designated by the Deputy Minister of National Revenue and Excise, before the prescribed substance or the prescribed item is released for import or export.

6. (1) No license is required by any person engaged in:

(a) the transport of goods for hire or reward in respect of the transport of any prescribed substance or any device or equipment necessary for such transport;

(b) prospecting for prescribed substances if such prospecting does not involve the removal of more than ten kilograms of uranium or thorium from any deposit thereof in any one calendar year;

(c) any use, sale or possession of a substance containing deuterium if

(i) such substance does not contain hydrogen having a greater concentration of deuterium than is normally found in nature, or

(ii) such use, sale or possession does not involve more than 10 kilograms of deuterium in any calendar year where such a substance does contain hydrogen having a greater concentration of deuterium than is normally found in nature;

(d) a substance containing naturally occurring radioactive isotopes of elements of atomic number less than 80 and in no greater concentration than is normally found in nature;

(e) a substance containing radioactive isotopes of elements of atomic number less than 90 if

(i) the quantity of such isotopes per kilogram of substance does not exceed the schedules quantity, and

(ii) any such isotopes on the surface of the substance are not, in the opinion of the Board or a designated officer, readily dispersible and the quantity of such isotopes on the surface of the substance does not exceed one-tenth of the scheduled quantity per square meter of substance;

(f) sources of ionizing radiation containing radioactive isotopes of elements of atomic number less than 90 if

(i) the quantity of such isotopes in each such source does not exceed the scheduled quantity, and

(ii) not more than 10 sources are required in any calendar year;

(g) any device incorporating a substance containing radioactive isotopes of elements of atomic number less than 90 or of americium isotope Am-241 if

(i) the total quantity of such isotopes per device does not exceed 10 times the scheduled quantity, and

(ii) [the design of the device and the method of incorporating the radioactive isotopes are approved by the Board or a designated officer]; and

(h) any incandescent mantle containing thorium.

(3) Nothing in subsection (2) authorizes the use or possession for any purpose without a license of any substance containing

(a) uranium isotope U-233; or

(b) uranium having a greater concentration of the isotope U-235 than is normally found in nature.

7. (1) The Board or a designated officer may issue a license for any purpose referred to in Section (3) or in respect of any device or equipment referred to in section (4) upon receipt of a written application from the person requiring the license.

(2) [The application for a license referred to in subsection (1) shall include the applicable fee set out in the *AECB Cost Recovery Fees Regulations* and shall set out such of the following information ad the Board or designated officer may require]:

(a) the nature and quantity of the prescribed substance and the purpose for which it is required;

(b) the maximum quantity of the prescribed substance likely to be required at any one time for the purpose set out in the application;

(c) a description of the premises in which the prescribed substance is to be located and of any equipment in connection with which it is to be used;

(d) a description of the measures to be taken to prevent theft, or loss or any unauthorized use of the prescribed substance;

(e) a description of the measures to be taken, including any plan in case of accident, to prevent the receipt by any person of a dose of ionizing radiation [or an exposure to radon daughters] in excess of any dose specified in respect of such person in Schedule II;

(f) a description of the method of diagnosing of the radioactive prescribed substance;

(g) a description of the qualifications, training, and experience of any person who is to use the prescribed substance; and

(h) any other information necessary to evaluate the application.

(3) [A license issued by the Board or a designated officer pursuant to subsection (1) may contain such conditions as the Board or the designated officer deems necessary in the interests of health, safety and security and, without limiting the generality of the foregoing, may include conditions respecting]

(a) the measures to be taken to prevent the receipt by any person of a dose of ionizing radiation [or an exposure to radon daughters] in excess of any dose specified in respect of such person in Schedule II;

(b) the monitoring devices and other methods for measuring the dose of ionizing radiation [or exposure to radon daughters] received by any person;

(c) instructions to be given to atomic radiation workers respecting the hazards of ionizing radiation and the procedures to be followed to limit exposure to ionizing radiation;

(d) the maximum quantity and concentration of radioactive or other hazardous material that may be discharged into the air and water as a result of the use of the prescribed substance;

(e) the method of disposing of the radioactive prescribed substance;

(f) the measures to be taken to prevent theft, loss or any unauthorized use of the prescribed substance; and

(g) the qualifications, training, and experience of any person who is to use or supervise the use of the prescribed substance or any device or equipment to which the license applies.

[(4) The Board or designated officer may issue a license to a person for any purpose referred to in subsection 5(1) on receipt of a written application from the person.

(5) A license issued by the Board or a designated officer pursuant to subsection (4) may contain such conditions as the Board or the designated officer deems necessary in the interests of health, safety and security.]

Part VI, Section 20 and 21

Loss or Theft of Prescribed Substances

20. (1) Every person in possession of a prescribed substance or operating a nuclear facility in which a prescribed substance is located shall, in the event of any loss or theft of such prescribed substance in a quantity exceeding ten times the scheduled quantity, make a report of such loss or theft within 24 hours to the inspector appointed for the place or area in which the loss or theft occurred and shall as soon as possible thereafter send a complete report of such loss or theft to the Board, such inspector and the person, if any, appointed

pursuant to section 16 as radiation safety adviser for the place or area in which the loss or theft occurred.

(2) For the purpose of subsection (1), loss does not include any loss necessarily incidental to any authorized use of the prescribed substance.

21. (1) Every person

(a) in charge of a nuclear facility

(b) in charge of a device or of equipment containing radioactive prescribed substances, or

(c) in possession of a radioactive prescribed substance shall, in the event of an occurrence that results or is likely to result in the receipt by any person of a dose of ionizing radiation [or of an exposure to radon daughters] in excess of any dose [or exposure] specified in respect of such person in schedule II,

(d) report such occurrence within 24 hours to the inspector appointed for the place or area in which the occurrence has taken place

(e) as soon as possible after the occurrence, send a complete report of such occurrence to the board, to the inspector referred to in paragraph (d) and to the person or committee appointed pursuant to section 16 to advise on radiation safety in respect of the place or area in which the occurrence has taken place.

(f) if the occurrence has resulted in the receipt by any person of a dose of ionizing radiation [or of an exposure to radon daughters] in excess of any dose [or exposure] specified in respect of such person in schedule II, send a copy of the report referred to in paragraph (e) to the place medical advisor appointed for the place or area in which the occurrence has taken place.

(2) In the event of any occurrence described in subsection (1), the person in charge of a nuclear facility or the equipment containing the prescribed substance or the person in possession of the prescribed substance, as the case may be, shall

(a) immediately take all appropriate measures to prevent or minimize exposure of any person to ionizing radiation [or radon daughters] resulting from such occurrence; and

(b) comply with any instructions that may be given by the inspector appointed for the place or area in which the occurrence has taken place.

Regulatory Agencies

NOTE: *Information in this section may change without notice*

Nuclear Regulatory Commission Regional Offices

Region	Address	Telephone
Region I: Connecticut, Delaware, District of Columbia, Maine Maryland Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.	USNRC 475 Allendale Road King of Prussia, PA 19406	(610) 337-5000 (FTS) 346-5000
Region II: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, Puerto Rico, South Carolina, Tennessee, Virginia Virgin Islands, and West Virginia.	USNRC 101 Marietta Street, NW Suite 2900 Atlanta, GA 30323	(404) 331-4053 (FTS) 242-4503
Region III: Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin	USNRC 799 Roosevelt Road Glen Ellyn, IL 60137	(708) 790-5500 (FTS) 388-5500
Region IV: Alaska, Arizona, Arkansas, California, Colorado, Hawaii, Idaho, Kansas, Louisiana, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, Pacific Trust Territories, South Dakota, Texas, Utah, Washington and Wyoming.	USNRC 611 Ryan Plaza Drive Suite 1000, Arlington, TX 76011	(817) 880-8100 (FTS) 728-8100

Region IV: Walnut Creek Field Office	USNRC Region IV Uranium Recovery Field Office 730 Simms Street P.O. Box 25325 Denver, CO 80225	(303) 236-2805 (FTS) 776-2805

Agreement States

Alabama Division of Radiation Control State Department of Public Health P.O. Box 303017 Montgomery, Alabama 36130-3017 (334)613-5391	**Arizona** Arizona Radiation Regulatory Agency 4814 South 40th Street Phoenix, Arizona 85040 (602) 255-4845
Arkansas Division of Radiation Control and Emergency Management Department of Health 4815 West Markham Street, Slot 30 Little Rock, Arkansas 72205-3867 (501) 661-2126	**California** Radiologic Health Branch Food, Drugs & Radiation Safety Division State Department of Health Services 714/744 P Street, P.O. Box 942732 Sacramento, California 94234-7320 (916) 322-3482
Colorado Radiation Control Division (RCD-DO-B1) Department of Public Health & Environment 4300 Cherry Creek Drive South Denver, Colorado 80222-1530 (303)692-3030	**Florida** Office of Radiation Control Department of Health and Rehabilitative Services 1317 Winewood Boulevard Tallahassee, Florida 32399-0700 (904) 487-2437
Georgia Radioactive Materials Program Department of Natural Resources 4244 International Parkway Atlanta, Georgia 30354 (404) 362-2675	**Illinois** Department of Nuclear Safety 1035 Outer Park Drive Springfield, Illinois 62704 (217)994-9928

Iowa Bureau of Radiological Health Iowa Department of Public Health Lucas State Office Building Des Moines, Iowa 50319 (515) 242-6280	**Kansas** X-Ray & RAM Control Section Department of Health & Environment Bureau of Air and Radiation Forbes Field, Building 283 Topeka, Kansas 66620 (913) 296-1562
Kentucky Conf. of Radiation Control Program Directors, Inc. 275 East Main Street Frankfort, Kentucky 40601 (502) 564-3700	**Louisiana** Radiation Protection Division Office of Air Quality and Radiation Protection Department of Environmental Quality 7290 Bluebonnet Road P.O. Box 82135 Baton Rouge, Louisiana 70808-2135 (504) 765-0160
Maine Division of Health Engineering Radiation Control Program State House, Station 10 Augusta, Maine 04333-0010 (207)287-5676	**Maryland** Radiological Health Program Air and Radiation Management Administration Maryland Department of the Environment 2500 Broening Highway Baltimore, Maryland 21224 (410) 631-3301
***Massachusetts** Radiation Control Program Department of Public Health 305 South Street, 7th Floor Jamaica Plain, Massachusetts 02130 (617) 727-6214	**Mississippi** Division of Radiological Health State Department of Health 3150 Lawson Street P.O. Box 1700 Jackson, Mississippi 38215-1700 (601) 354-6167
Nebraska Nebraska Department of Health 3016 Centennial Mall Drive Lincoln, Nebraska 68509-5007 (402) 471-6444	**Nevada** Radiological Health Section Department of Human Resources 505 East King Street Carson City, Nevada 89710 (702) 687-5394

New Hampshire Radiological Health Bureau Division of Public Health Services Health and Welfare Building 6 Hazen Drive Concord, New Hampshire 03301-6527 (603) 271-4588	**New Mexico** Bureau of Hazardous & Radioactive Materials Water and Waste Management Division Department of Environment P.O. Box 26110, 2044 Galisteo Road Santa Fe, New Mexico 87502 (505) 827-1557
New York Radiological Health Unit Division of Safety and Health New York Sate Department of Labor New York State Office Campus Building 12, Room 457 Albany, New York 12240 (518) 457-1202	**North Carolina** Division of Radiation Protection Department of Environment, Health & Natural Resources 3825 Barrett Drive P.O. Box 27687 Raleigh, North Carolina 27609 (919) 571-4141
North Dakota Division of Environmental Engineering Department of Health 1200 Missouri Avenue, Room 304 P.O. Box 5520 Bismarck, North Dakota 58502-5520 (701) 328-5188	***Ohio** Bureau of Radiation Protection Division of Environmental Health Ohio Department of Health P.O. Box 118 Columbus, Ohio 43266 (614) 644-2727
***Oklahoma** Radiation Management Section Department of Environmental Quality 1000 NE 10th Street Oklahoma City, Oklahoma 73117-1212 (405)271-7484	**Oregon** Radiation Protection Services State Health Division Department of Human Resources 800 N.E. Oregon Street, Suite 260 Portland, Oregon 97232 (503) 731-4014
***Pennsylvania** Bureau Of Radiation Protection Department of Environmental Protection P.O. Box 8469	**Rhode Island** Division of Occupational and Radiologic Health Department of Health Room 206 Cannon Building,

Harrisburg, Pennsylvania 17105-8469 (717)787-3720	3 Capital Hill Providence, Rhode Island 02908-5097 (401) 277-2438
South Carolina Division of Radioactive Waste Management Bureau of Solid and Hazardous Waste Department of Health and Environmental Control 2600 Bull Street Columbia, South Carolina 29201 (803) 737-7400	**Tennessee** Division of Radiological Health Department of Environment and Conservation L & C Annex, 3rd Floor 401 Church Street Nashville, Tennessee 37243-1532 (615)532-0364
Texas Bureau of Radiation Control Texas Department of Health 1100 W. 49th Street Austin, Texas 78756-3189 (512) 834-6688	**Utah** Division of Radiation Control Department of Environmental Quality 168 North 1950 West P.O. Box 144850 Salt Lake City, Utah 84114-4850 (801) 536-4250

Washington Division of Radiation Protection Department of Health Airdustrial Center, Building #5 P.O. Box 47827 Olympia, Washington 98504-7827 (360)753-3353

*Letter of intent received from Governor to become an Agreement State

Canadian Atomic Energy Control Board

The Canadian Atomic Energy Control Board (AECB) can be contacted at:

Atomic Energy Control Board
2805 Slater Street
Ottawa, Ontario, K1P 5S9 (613) 995-5894

Wipe Test Agencies

Wipe test kits may be ordered directly from the agency providing the service. In locations, other than Canada and the US, contact your PerkinElmer Photovac representative for further information

United States

National Leak Test Center
P.O. Box 486
North Tonawanda, New York 14120
Tel: 716-693-0550

Canada

Contact the AECB for more organizations providing leak testing services.

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